
**ENERGY CONSERVATION OPPORTUNITIES,
OIL SUBSTITUTION ALTERNATIVES
AND IMPLEMENTATION STRATEGIES**

for communities of the Windigo Tribal Council, Ontario

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AND IMPLEMENTATION STRATEGIES**
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Windigo Tribal Council

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EXECUTIVE SUMMARY

INTRODUCTION

This is the final report of a study carried out on behalf of the Windigo Tribal Council under the federal Remote Community Demonstration Program (RCDP). The study is entitled:

Energy Conservation Opportunities and Oil Substitution
Alternatives and Implementation Strategies for the
Communities of the Windigo Tribal Council, Ontario

OBJECTIVES

The overall objectives of this study are:

- to identify, evaluate and rank energy conservation/oil substitution options available in the eligible Windigo Tribal communities;
- to prepare a detailed community energy plan for the community of Sachigo Lake as well as more general plans for each of the other eligible communities;
- to initiate a process of technology transfer to the communities of the Windigo Tribal Council.

SCOPE OF THE STUDY

The study's scope includes energy conservation/oil substitution options in three specific areas: Buildings; Heating systems; and Diesel electricity generation facilities. Alternative electricity generation options are not considered.

The primary focus of the study is the remote native community of Sachigo Lake. However, 5 additional communities within the Windigo Tribal Council were added to the study's initial focus. These communities include: Bearskin Lake, Weagamow (Round) Lake, Cat Lake, Muskrat Dam and Slate Falls (see Map #1 overleaf).

Site visits to each of these communities were carried out during the period January 9-17 (inclusive) 1984.

TECHNICAL OPTIONS ASSESSED

The study assessed seven specific technical options:

- new energy efficient housing including heating options
- upgrading of insulation, air tightness, and heating systems in existing housing
- upgrading of insulation, air tightness, and heating systems in Band-owned commercial buildings
- upgrading of insulation and air tightness in schools
- substitution of wood heating in schools and commercial buildings
- waste heat recovery from diesel power systems
- new energy efficient commercial buildings including heating options

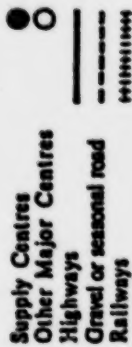
COMMUNITY OBJECTIVES AND PRIORITIES

Table 1 presents a summary of the priorities assigned to each of the above options by each community. A scale of 0 to 5 is used; 5 indicates highest priority and 0 indicates no interest. The priorities assigned serve to emphasize the high level of concern given to more comfortable homes and buildings and to employment creation.

MAP # 1

WINDIGO STUDY
COMMUNITIES

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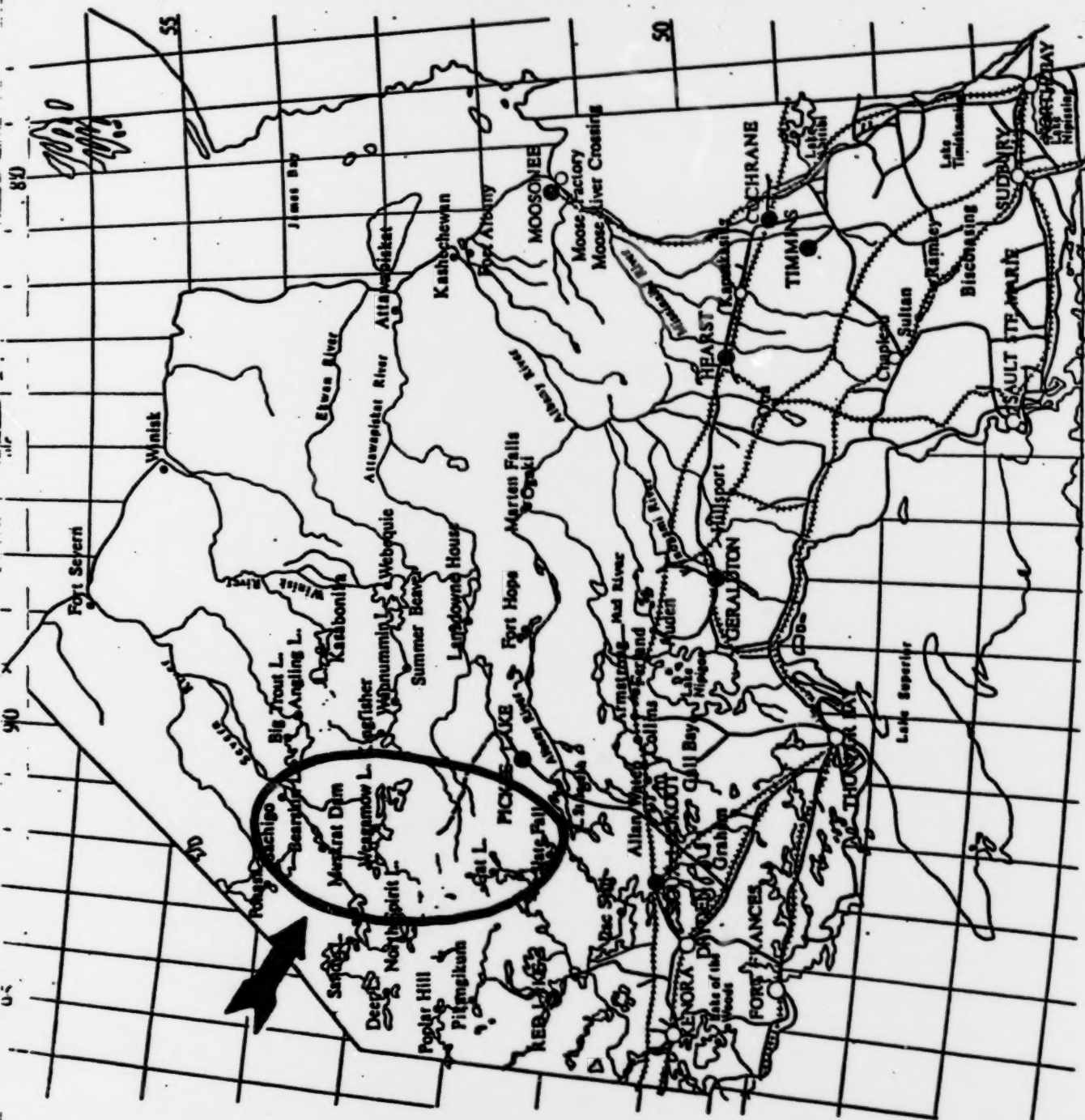


Table 1
COMMUNITY PRIORITIES

Community	New Housing	Exis- ting Housing	Band Comm- ercial Bldgs	School Insul- ation	School Wood Heating	Diesel Waste Heat	New Comm- ercial Bldgs
	(A)	(B)	(C)	(D)	(E)	(F)	(G)
Sachigo Lake	5	1	2	3	5	1	4
Bearskin Lk	5	3	4	3	5	4	4
Weagamow Lk	5	2	4	3	5	4	4
Cat Lake	5	2	1	1*	4	3	4
Muskrat Dam	5	2	1	1*	5	3	4

* These are newer schools.

STUDY FINDINGS AND RECOMMENDATIONS

The major study findings and recommendations related to each of the above options are presented below:

- A. **New Housing:** The report presents 4 new housing designs. Each design incorporates energy efficiency considerations and features which generally make the house more compatible with

northern lifestyles. The estimated materials and labour costs for the four new houses range from \$34,000 to \$53,000. Three of the 4 designs are estimated to cost \$42,000 or less and therefore can be constructed within existing DIAND allocations. Based on the results of the HOTCAN computer heat loss analysis, annual space heating requirements are estimated to be about 25% of current requirements.

The report recommends that the existing community new housing programs incorporate new energy efficient house designs and construction techniques as quickly as possible. A detailed implementation plan is presented. The major emphasis of the implementation plan is the provision of technical training to local residents in energy efficient construction techniques.

- B. **Upgrading Existing Housing:** The report recommends three groups of retrofit measures for existing housing: upgrading of attic insulation; air sealing; and installation of efficient radiant heat airtight wood stoves. Detailed specifications for the application of each retrofit measure are provided including numerous line drawings. Some homes have already installed efficient wood stoves and Class-A prefabricated chimneys. In these homes, weatherstripping and air sealing material costs are estimated to be \$250 plus transportation. If a new wood stove and chimney is required, an additional retrofit cost of about \$1,000 plus transportation is estimated. Implementation of the range of recommended retrofit measures is expected to reduce wood consumption by up to 50%. The retrofit measures will also reduce uncomfortable drafts and help to extend the life of the building by reducing moisture damage. Two alternative implementation plans are outlined.

- C. **Upgrading Existing Band Buildings:** The band offices in Bearskin Lake and Weagamow Lake were the two band owned buildings where the greatest interest and opportunity for retrofit measures were noted. In the Bearskin Lake band office, uninsulated warm air distribution ducts running through the attic and the lack of any ceiling in the furnace room results in very significant heat losses and poor heat distribution. Further, a new wood furnace has been installed beside the oil furnace but due to improper installation, it is inoperable. Recommended remedial measures for the existing oil furnace are estimated to reduce fuel oil consumption by 40-50% for an annual saving of about \$2,000 (at present fuel prices). Further savings are possible by making the wood furnace operable and substituting locally purchased wood fuel for oil.

The Band office in Weagamow Lake is a two-storey log building. It is currently heated by two barrel stoves, centrally located on each floor. These stoves do not provide comfortable or efficient space heat:

- . they burn down quickly at night, resulting in the building being very cold each morning
- . it is difficult to control their heat output, resulting in frequent over-heating of parts of the building
- . hot air distribution is inadequate, resulting in some portions of the building being overheated while other portions remain too cold.

The recommended remedial actions involve the installation of new efficient radiant heat wood stoves and the installation of circulating fans. These measures are expected to reduce wood fuel consumption by 50% and greatly increase comfort.

- D. Upgrading School Facilities:** A detailed energy audit was performed on the school at Sachigo Lake. Schools in the other communities were inspected but in less detail. Based on the results of the energy audit, the report presents specific retrofit measures. These include upgrading attic insulation to at least RSI 7 (R40) and performing specific air sealing measures. Detailed specifications and application procedures are presented for each recommended measure. Estimated retrofit costs for the Sachigo school are about \$3,700 and are estimated to reduce annual fuel oil consumption by about 28% (or \$3,600 at present prices). The payback period is therefore about 1 year.

At the present time, the maintenance and/or upgrading of school facilities remains a DIAND responsibility. DIAND has already initiated a program for upgrading the energy efficiency of many of its schools. It is expected that the detailed specifications provided in the report will assist them in their efforts.

- E. Substitution of Wood for Oil in School Heating Systems:** The school at Sachigo Lake is heated by an oil-fired boiler which is scheduled for major renovations or replacement in the near future. The report recommends that Sachigo initiate discussions with DIAND aimed at ensuring that when renovations occur, the existing oil boiler is replaced by a dual-fuel (wood/oil) boiler. Incremental costs for a dual fuel rather than an oil boiler are estimated to be about \$5,000 for the heating system and about \$5,000 for required modifications to the boiler room. Implementation of this option is expected to displace 15,000 litres of fuel oil annually and require the substitution of approximately 35 cords of wood. Assuming the current price of fuel oil (65¢/litre) and a wood price of

\$150/cord, annual savings are about \$4,500. Two permanent part-time local jobs would also be created. The simple payback period is 2.2 years at Sachigo Lake. Recommendations are presented for each of the other communities and similar (or shorter) payback periods are expected. The communities of Muskrat Dam and Slate Falls already have wood heating systems installed in their schools.

- F. **Heat Recovery from Community Power Systems:** Weagamow Lake is the only Windigo community currently served by a community power system. In Sachigo Lake and Bearskin Lake, community power is in the final stages of installation. Cat Lake and Muskrat Dam do not yet have community power but expect to receive service within the next 5 years. No community power is currently scheduled for Slate Falls.

There are specific opportunities in Bearskin Lake and Weagamow Lake for the use of heat recovered from community power generators. In Bearskin Lake, there are plans to build a community economic development centre close to the new community power generator building. There will be a year-round demand for hot water in the centre for a laundromat and fitness centre which could be supplied in part by heat recovered from the community power generators. In Weagamow Lake, there are plans to build a garage/warehouse building near the airport. There will be a seasonal space heating demand in both buildings which could be met by heat recovered from the community power generators. At present these new facilities, in both Bearskin Lake and Weagamow Lake are at a preliminary stage of development. Final site selection, building design specifications and economic feasibility have to be established. Consequently, the Study Team could provide only general cost estimates.

On the basis of the data provided for the Bearskin Lake facilities, the installation of a waste heat recovery system is estimated to cost in the range of \$100,000. Annual savings are estimated to be about \$24,000 in projected propane consumption for hot water heating in the community development centre. The simple payback period is therefore about 4 years. The proximity of the centre to the existing diesel sets will be one of the most critical factors affecting economic feasibility.

On the basis of the data provided for the Weagamow Lake facilities (an 1800ft² warehouse and 2500ft² garage) the installation of a waste heat recovery system is estimated to cost in the range of \$65,000. Annual savings are estimated to be about \$10,400 against an oil space heating system and about \$6,800 against a wood space heating system (at \$150/cord). The simple payback against oil is therefore about 6 years and about 9.5 years against wood.

Community power in Cat Lake and Muskrat Dam has not yet reached the design stage. This means that the location of the diesel sets has not yet been fixed. Both communities are also in the midst of community planning projects in which separate areas of the community are being designated respectively, as residential and institutional/commercial zones.

The report strongly encourages both communities to consider the future location of their community power systems within their present community planning process. The report recommends that a central location within the planned institutional/commercial zone be established for the future community power system. This will maximize the future potential use of waste heat for the heating of new schools, stores, health centres, etc.

- G. New Commercial Buildings:** New commercial buildings are being planned in many of the Windigo communities. Most of the buildings will be single storey wood frame structures with floor areas between 100 and 400m² (1100 to 4300ft²). Opportunities exist to construct these new commercial buildings to energy efficiency standards almost as high as can be obtained in new housing. Specific construction features that should be used in these new buildings are outlined.

It is estimated that incorporation of the recommended construction features will reduce annual space heating requirements for commercial buildings (schools, stores, etc.) from the present average of about 1.5GJ/m² (60 litres of oil/m²/year) to about 0.75 GJ/m². The payback period for the addition of energy efficiency construction features will generally be less than 1 year.

COMMUNITY ENERGY PLANS

A community energy plan is presented for each community and considers:

- the feasibility of the identified technical options
- community objectives/priorities
- RCDP objectives of reduced fuel oil consumption
- timing and community resources

Options are recommended for both short term and longer term applications. Short term options are those considered ready for immediate action; longer term options are indicated where significant potential benefit exists but local conditions (ie, stage of planning) are not yet at a stage for immediate action.

Nonetheless, consideration of these longer term options should be incorporated into future community plans.

In accordance with the scope of the study, the community of Sachigo Lake is emphasized.

STUDY CONCLUSIONS

The report concludes that implementation of the technical options presented within each of the community energy plans will not only result in significant energy savings but also will contribute to more comfortable living conditions and local employment development.

OCCASIONS D'ECONOMISER L'ENERGIE ET OPTIONS EN MATIERE DE
 REMPLACEMENT DU PETROLE ET STRATEGIES DE MISE EN OEUVRE
DANS LES COLLECTIVITES DU CONSEIL TRIBAL WINDIGO (ONTARIO)

Résumé

Voici les objectifs de cette étude:

- identifier, évaluer et classer les options en matière d'économie d'énergie et de remplacement du pétrole qui sont disponibles dans les collectivités admissibles du Conseil Tribal Windigo;
- préparer un plan détaillé de gestion de l'énergie pour les collectivités de Sachigo Lake, ainsi que des plans plus généraux pour chacune des autres collectivités admissibles; et
- mettre en oeuvre un processus de transfert de la technologie aux collectivités du Conseil Tribal Windigo.

La portée de l'étude comprend des options en matière d'économie d'énergie et de remplacement du pétrole dans trois domaines particuliers: le bâtiment; les systèmes de chauffage; et les installations de production d'électricité à moteur diesel. Les solutions de rechange concernant la production d'électricité ne sont pas examinées.

L'étude est axée d'abord sur la collectivité autochtone de Sachigo Lake, située dans une région éloignée. Toutefois, cinq collectivités du Conseil Tribal Windigo ont été ajoutées à l'objet initial de l'étude. Ces collectivités comprennent: Bearskin Lake, Weagamow (Round) Lake, Cat Lake, Muskrat Dam et Slate Falls.

L'étude a évalué sept options techniques particulières:

- nouvelles habitations, notamment des options en matière de chauffage
- amélioration de l'isolation thermique, de l'étanchéité et des systèmes de chauffage dans des maisons existantes;
- amélioration de l'isolation thermique, de l'étanchéité et des systèmes de chauffage dans des bâtiments commerciaux qui appartiennent à une bande;
- amélioration de l'isolation thermique et de l'étanchéité dans les écoles;
- remplacement du mazout par le bois aux fins du chauffage des écoles et des bâtiments commerciaux;
- récupération des rejets thermiques des systèmes électriques à moteur diesel;
- nouveaux bâtiments commerciaux, notamment des options en matière de chauffage.

Les principales conclusions et recommandations de l'étude relativement à chacune des options susmentionnées sont présentées ci-dessous.

- A. Nouvelles habitations: Le rapport présente quatre nouveaux concepts en matière d'habitation. Chaque concept tient compte de considérations et d'éléments en matière de rendement énergétique qui, en général rendent la maison plus compatible avec les genres de vie qui prévalent dans le Nord. Les coûts estimatifs des matériaux et de

la main-d'oeuvre pour les quatre nouvelles maisons varient de 34 000\$ à 53 000 \$. Les coûts de trois des quatre maisons sont estimés à au plus 42 000 \$ et leur construction peut par conséquent être entièrement payée à même les sommes déjà affectées par le ministère des Affaires indiennes et du Nord (MAIN). À partir des résultats de l'analyse informatisée (HOTCAN) des pertes de chaleur, les besoins annuels de chauffage des locaux sont estimés à environ 25 % des besoins actuels.

Le rapport recommande que les programmes existants de construction domiciliaire dans ces collectivités comprennent, le plus tôt possible, les nouvelles techniques de construction et les nouveaux concepts d'habitation qui permettent d'obtenir un bon rendement énergétique. Un plan de mise en oeuvre détaillé est présenté. Le mot d'ordre du plan de mise en oeuvre est le transfert de la technologie.

- B. **Rénovation des maisons existantes:** Le rapport recommande trois groupes de mesures de réfection, soit l'amélioration de l'isolation thermique des entretoits; le calfeutrage; et l'installation de bons poêles à bois étanches qui transmettent la chaleur à l'espace environnant. Aux fins de l'application de chaque mesure de réfection, on fournit des instructions détaillées accompagnées de nombreux dessins au trait.

Dans plusieurs maisons, on a déjà installé de bons poêles à bois et des cheminées préfabriquées du type A. Pour ces maisons, les coûts des matériaux relativement à la pose de coupe-bise et au calfeutrage sont estimés à 250 \$, sans compter les frais de transport. Lorsqu'une nouvelle cheminée et un nouveau poêle à bois sont requis, le coût additionnel de la rénovation est estimé à environ 1 000 \$, plus les frais de transport. La mise en oeuvre de la gamme de mesures de réfection recommandées devrait se traduire par des coupures dans la consommation de bois pouvant aller jusqu'à 50 %. De plus, les mesures de réfection rendront les maisons plus confortables en réduisant les courants d'air et augmenteront leur durée de vie en diminuant la détérioration causée par l'humidité. Les grandes lignes de deux plans de mise en oeuvre facultatifs sont présentées.

- C. **Rénovation de bâtiments qui appartiennent à une bande:** Les bureaux des bandes de Bearskin Lake et de Weagamow Lake ont été les deux bâtiments, propriété d'une bande, où ont été identifiés le plus grand nombre d'occasions et le plus grand intérêt en ce qui concerne les mesures de réfection.

Dans le bureau de la bande de Bearskin Lake, les conduites d'air chaud non recouvertes de matière isolante qui sont installées d'un bout à l'autre de l'entretroît et l'absence de plafond dans la pièce où est situé le poêle se traduisent par des pertes de chaleur considérables et une mauvaise distribution de la chaleur. Qui plus est, un nouveau poêle à bois a été installé à côté de la chaudière à mazout, mais il est inopérant en raison d'une installation inappropriée. Les mesures correctrices recommandées pour la chaudière au mazout devraient réduire la consommation de mazout de 40 à 50 % et permettre une économie annuelle d'environ 2 000 \$ (aux prix actuels du mazout). D'autres économies sont possibles si l'on rend le poêle à bois opérant et si l'on remplace le mazout par du bois de chauffage acheté sur place.

Le bureau de la bande de Weagamow Lake est un bâtiment en rondins à deux étages. Il est actuellement chauffé au moyen de deux barils tenant lieu de chaudières qui sont situés au milieu de chaque étage. Ces poêles ne sont pas efficaces et n'assurent pas le confort.

Les mesures correctrices recommandées comprennent l'installation de nouveaux poêles à bois qui transmettent la chaleur à l'espace environnant et de ventilateurs fixés au plafond. Ces mesures devraient réduire la consommation de bois de chauffage de 50 % et augmenter considérablement le confort.

- D. **Rénovation des installations scolaires:** L'école de Sachigo Lake a fait l'objet d'une vérification détaillée du rendement énergétique. Dans les autres collectivités, les écoles ont été inspectées de façon plus générale. A partir des résultats de la vérification du rendement énergétique, le rapport présente des mesures de réfection particulières. Celles-ci comprennent l'amélioration de l'isolation thermique des entretoits jusqu'à la valeur RSI 7 (R40) au moins et l'application de mesures particulières de calfeutrage. Des méthodes d'application et des instructions détaillées sont présentées pour chaque mesure recommandée. Les coûts estimatifs de la réfection à l'école Sachigo sont d'environ 3 700 \$ et ils devraient permettre de réduire d'environ 28 % la consommation annuelle de mazout (pour une économie de 3 600 \$ aux prix actuels). Le délai de récupération est par conséquent d'environ 1 an.

Pour le moment, l'entretien et la rénovation des installations scolaires demeurent la responsabilité du MAIN. Le MAIN a déjà mis en oeuvre un programme qui vise à améliorer le rendement énergétique de nombre de ses écoles. On s'attend que les instructions détaillées du rapport les aident à atteindre leur objectif.

- E. **Remplacement du mazout par le bois aux fins du chauffage des écoles:** L'école de Sachigo Lake est chauffée au moyen d'une chaudière au mazout qui devra être remplacée ou faire l'objet d'importants travaux de rénovation dans un proche avenir. Le rapport recommande que la collectivité entame des pourparlers avec le MAIN afin de s'assurer que les travaux de rénovation comprendront le remplacement de la chaudière au mazout par une chaudière mixte au bois et au mazout. Les coûts supplémentaires que représente l'installation d'une chaudière mixte plutôt qu'une chaudière au

mazout sont estimés à environ 5 000 \$ en ce qui concerne le système de chauffage et à quelque 5 000 \$ pour ce qui est des modifications requises dans la chaufferie. La mise en oeuvre de cette option devrait permettre de remplacer, annuellement, 15 000 litres de mazout par environ 35 cordes de bois. Si l'on fonde les calculs sur le prix actuel du mazout (65 ¢ le litre) et sur un prix de 150 \$ la corde pour le bois, les économies annuelles sont d'environ 4 500 \$. Deux emplois permanents à temps partiel seraient également créés sur place. Dans le cas de Sachigo Lake, le délai de récupération est de 2,2 ans si l'on ne tient pas compte de l'inflation. Des recommandations sont présentées pour chacune des autres collectivités et des délais de récupération semblables (ou plus courts) sont prévus. Les écoles des collectivités de Muskrat Dam et de Slate Falls sont déjà dotées de systèmes de chauffage au bois.

- F. Récupération de la chaleur s'échappant des génératrices d'électricité: Weagamow Lake est actuellement la seule collectivité du conseil Windigo à être électrifiée grâce à un système interne. A Sachigo Lake et à Bearskin Lake, l'installation des génératrices d'électricité est presque terminée. Les collectivités de Cat Lake et de Muskrat Dam ne produisent pas encore d'électricité, mais elles s'attendent à être pourvues du service d'ici 5 ans. Aucun projet d'électrification interne n'est actuellement prévu pour Slate Falls.

A Bearskin Lake et à Weagamow Lake, il existe des débouchés précis pour la chaleur récupérée des génératrices d'électricité. A Bearskin Lake, on a l'intention de construire un centre communautaire de développement économique près du nouveau bâtiment où seront installées les génératrices d'électricité. La blanchisserie automatique et les installations de conditionnement physique du centre se traduiront par une demande d'eau chaude continue qui pourrait être en partie satisfaite au moyen de la chaleur récupérée des génératrices d'électricité. A Weagamow Lake, on a l'intention de construire un garage et un entrepôt près de l'aéroport. Les deux édifices représenteront une demande de chauffage saisonnière qui pourrait être comblée au moyen de la chaleur récupérée des génératrices d'électricité. Dans les deux collectivités, la mise au point de ces installations est actuellement à une étape préliminaire. Il reste à établir l'emplacement et les spécifications architecturales des bâtiments et à déterminer si le projet est économiquement réalisable. En conséquence, l'équipe chargée de l'étude n'a pu donner que des estimations générales du coût.

A partir des données sur les installations, le coût du système de récupération des rejets thermiques pour Bearskin Lake est estimé à environ 100 000 \$. Etant donné la consommation de propane prévue aux fins du chauffage de l'eau, les économies annuelles devraient être d'environ 24 000 \$ au centre de développement communautaire. Le délai de récupération est par conséquent d'environ quatre ans si l'on ne tient pas compte de l'inflation. La proximité du centre par rapport aux génératrices à moteur diesel existantes sera l'un des facteurs les plus critiques au moment de déterminer la faisabilité en tenant compte des paramètres économiques.

A partir des données sur les installations (un entrepôt de 1 800 pi² et un garage de 2 500 pi²), le coût du système de récupération des rejets thermiques pour Weagamow Lake est estimé à environ 65 000 \$. Pour ce qui est du chauffage de ces bâtiments, les économies annuelles sont estimées à environ 10 400 \$ dans le cas d'un système au mazout, et à environ 6 800 \$, si le système est alimenté au bois et que le combustible coûte 150 \$ la corde. En conséquence, le délai de récupération calculé sans tenir compte de l'inflation est d'environ six ans dans le cas du mazout, et d'environ 9.5 ans pour ce qui est du bois.

L'électrification de Cat Lake et de Muskrat Dam n'a pas encore atteint l'étape de la conception. Ce qui signifie que l'emplacement des génératrices à moteur diesel n'a pas encore été établi. Les deux collectivités sont également en train d'exécuter des projets de planification dans le cadre desquels elles identifient des régions distinctes du territoire qui leur est réservé comme étant des zones d'habitation ou des zones d'affaires et de services.

Le rapport encourage fortement les deux collectivités à tenir compte de l'emplacement futur de leurs génératrices d'électricité dans le processus actuel de planification communautaire. Le rapport recommande que soit établi un emplacement central à l'intérieur de la zone réservée aux affaires et aux services, aux fins de la future installation de production d'électricité. Il sera ainsi possible de maximiser l'utilisation éventuelle des rejets thermiques aux fins du chauffage des nouvelles écoles, des magasins, des centres de santé, etc.

- G. Nouveaux bâtiments commerciaux: De nouveaux édifices commerciaux sont en voie de planification dans de nombreuses collectivités du conseil Windigo. La plupart des bâtiments seront des structures en bis à un étage ayant une superficie de 100 à 400 m² (de 1 100 à 4 300 pi²). On peut construire ces nouveaux édifices commerciaux de façon à obtenir un rendement énergétique presque aussi élevé que celui qu'il est possible d'enregistrer dans les nouvelles maisons. Les grandes lignes des aspects particuliers que présente obligatoirement la construction de ces nouveaux édifices sont énoncées.

L'on estime que, pour ce qui est des édifices commerciaux (écoles, magasins, etc.), l'utilisation des techniques de construction recommandées réduira les besoins annuels de chauffage pour les faire passer de la moyenne actuelle d'environ 1,5 GJ/m² (60 litres de pétrole/m²/année) à environ 0,75 GJ/m². Le délai de récupération découlant de l'utilisation de techniques permettant d'obtenir un bon rendement énergétique sera généralement inférieur à 1 an.

Un plan communautaire de gestion de l'énergie est présenté pour chaque collectivité et considère:

- . la faisabilité des options techniques identifiées
- . les priorités et les objectifs de la collectivité
- . les objectifs du PDCE en ce qui concerne la réduction de la consommation de mazout
- . l'opportunité des mesures et les ressources de la collectivité

Des options sont recommandées aux fins d'applications à court terme et à long terme. Les options à court terme sont celles qui peuvent être mises en oeuvre sans délai; les options à long terme sont mentionnées lorsqu'il est possible d'en tirer d'importants avantages, mais que les conditions locales (c.-à-d. l'étape de planification) ne permettent pas encore de les mettre en oeuvre.

Néanmoins, ces options à long terme doivent être prises en considération dans les futurs plans de développement communautaire.

Conformément à la portée de l'étude, une importance particulière est accordée à la collectivité de Sachigo Lake.

Le rapport conclut que la mise en oeuvre des options techniques présentées dans chacun des plans communautaires de gestion de l'énergie ne se traduira pas seulement par des économies d'énergie considérables, mais contribuera également à améliorer les conditions de vie dans ces collectivités et à créer des emplois dans la région.

Cette étude a été effectuée par Marbek Resource Consultants Ltd. en association avec R.G. Bell and Associates et Shelter Construction and Development Ltd. pour le Conseil Tribal Windigo à l'aide d'une subvention du Programme de démonstration dans les collectivités éloignées d'Energie, Mines et Ressources Canada.

BACKGROUND

1.1 Introduction

This is the final report of a study carried out on behalf of the Windigo Tribal Council under the federal Remote Community Demonstration Program (RCDP). The study is entitled:

Energy Conservation Opportunities and Oil Substitution Alternatives and Implementation Strategies in the Communities of the Windigo Tribal Council, Ontario.

1.2 Objectives

The overall objectives of this study are:

- . to identify, evaluate and rank energy conservation/oil substitution options available in the eligible Windigo Tribal communities;
- . to prepare a detailed community energy plan for the community of Sachigo Lake as well as more general energy plans for the other eligible communities;
- . to initiate a process of technology transfer to the communities of the Windigo Tribal Council.

1.3 Scope of the Study

The scope of this study is specifically defined with respect to both the range of technical options to be assessed and the level of effort to be accorded to the various eligible communities:

1.3.1 Technical Options: The technical options to be assessed under this study are confined to the following areas:

Buildings: What is the technical and economic feasibility of thermally upgrading existing buildings?

How can new buildings (most particularly residences) be built to be more energy efficient and comfortable?

Heating Systems: Can existing wood heating systems be upgraded to provide safer, more efficient and comfortable space heat?

What is the technical and economic feasibility of converting existing oil heating systems to wood/oil combination systems?

Waste Heat Recovery from Diesel Generators: What are the opportunities as well as technical and economic feasibility of capturing waste heat from existing or new diesel sets for use in existing or new buildings?

1.3.2 Level of Effort: The original proposal presented to the Windigo Tribal Council was intended to focus on only one (1) community, to be selected by the Council. However, upon further consultation with the Council, the Study Team agreed to extend the number of communities to be visited within the original budget. Within this amended scope it was agreed that:

- Sachigo would be the major focus of the study and would be referred to as the "initial" community. Study results would be presented in detail for this community.

- Site visits would be carried out in 5 additional communities of the Windigo Council - Bearskin Lake, Weagamow (Round) Lake, Cat Lake, Muskrat Dam and Slate Falls. Study results for these communities would be presented in less detail than for Sachigo, ie, opportunities would be identified, but the technical and economic assessments would rely heavily on a comparison with similar ones assessed in detail for Sachigo. Opportunities unique to any of these latter communities would be identified but actual assessments would be more general in scope.

1.4 Structure of this Report

This report is presented in 3 parts. Part A provides an outline of the study's approach and presents an overview of the technical options identified. Part B consists of 7 sections. Each section provides both a detailed assessment and an implementation plan for a specific technical option identified in Part A. Part C presents a recommended community energy plan for Sachigo Lake and more general recommendations for community energy plans in the remaining communities.

PART A

STUDY OVERVIEW

INTRODUCTION

Part A outlines the study's approach and provides an overview of the technical options identified during the community site visits. Each of the options presented were discussed in detail with Band members during the site visit. Consequently, a summary table indicating initial community priorities is presented.

SECTION 2

STUDY OVERVIEW

2.1 Approach

The study was undertaken in six stages.

- | | |
|----------|--|
| Stage 1: | Site visit and evaluation of options for Sachigo Lake |
| Stage 2: | Site visit and evaluation of options in other eligible communities |
| Stage 3: | Detailed option analysis |
| Stage 4: | Preparation of implementation plans |
| Stage 5: | Final report |
| Stage 6: | Presentation to Windigo Tribal Council |

Stages 1 and 2 involved site visits by the project team to, respectively, the initial community of Sachigo Lake and to the other eligible communities of Bearskin Lake, Weagamow (Round) Lake, Cat Lake, Muskrat Dam and Slate Falls. The Windigo Council facilitated the site visits by arranging a travel schedule and by identifying a Contact Person in each community -- generally a Band Councillor or Economic Development Officer employed by the Band Administration.

The Study Team spent approximately 2 days in Sachigo and between one half and a full day in each of the other communities except Slate Falls. Scheduling difficulties prevented the Study Team from establishing a time to meet

with community representatives in Slate Falls. However, a brief stop-over and review of facilities was carried out. In each of the other communities, the approach (approximately) followed included:

- . An initial meeting with the Band
- . An inspection/audit of facilities
- . Discussion with other community members

Each is described below.

Initial Meeting: Upon arrival in each community, the Study Team met with the Band and community representatives selected by the Community Contact Person. This meeting, generally lasting from one to two hours, provided opportunities for an exchange of ideas vis-à-vis possible options as well as allowing the Study Team to become familiar with current and planned Band initiatives. At the conclusion of each initial meeting, a list of "priority" options was drawn up and arrangements were made to provide the Study Team with access to the necessary facilities and/or persons.

During the initial meeting the Study Team typically met with most (or all) of the following persons:

- . the Community Contact Person
- . the Chief and/or Councillors
- . the Band Housing Co-ordinator
- . the Economic Development Officer
- . the Band Administrator
- . Other interested residents or Band staff.

Inspection/Audit of Facilities: Based on the options discussed and identified as priorities in the initial meeting, facilities were inspected and necessary data acquired. Typically these included:

- . an inspection of new housing currently under construction
- . an inspection of a sample of existing homes
- . an inspection/audit of major existing facilities, in particular the band office, school and teacherages and current heating systems
- . an inspection of prime power diesel sets
- . an inspection of proposed sites of future development

Discussions: In addition to the formal initial meeting and the actual inspection of facilities, other community residents such as the school principal, teachers, janitors and diesel attendants were contacted. These discussions provided further insight into both the desirability and practicability of the identified options. For example, the school principal's reaction to the possibility of converting the school's heating system from oil to a wood/oil combination system was sought.

In isolated cases, the site visit provided an opportunity to meet with repair and installation crews, ie. Ontario hydro workers, Bell Canada maintenance crews, furnace/boiler (school) repair and installation crews, etc.

Stage 3 involved the detailed analysis of the options identified during the site visits. Specifically, each option was assessed with respect to:

- . technical feasibility
- . projected cost and rate of return on investment
- . energy savings, particularly oil
- . compatibility with local attitudes
- . local economic, social and/or environmental impacts

At the conclusion of Stage 3, an interim report summarizing the assessment of technical options was prepared and presented both to the Windigo Tribal Council and Energy, Mines and Resources.

Following a review period, in which Windigo and EMR had an opportunity to comment on the interim report, an implementation plan was prepared in Stage 4 for each of the options identified in Stage 3.

In Stage 5 a final report, containing the results of Stages 1 through 4 inclusive was prepared. This present report represents Stage 5 of the study.

The final stage of the study involved a formal presentation of the study's results to the Windigo Tribal Council.

2.2 Overview of Technical Options

Seven options were jointly identified and assessed in each of the communities visited:

- new energy efficient housing including heating options
- upgrading of insulation, air tightness, and heating systems in existing housing
- upgrading of insulation, air tightness and heating systems in existing Band buildings
- upgrading of insulation and air tightness in schools
- substitution of wood for oil in school heating systems
- waste heat recovery from diesel power systems
- new energy efficient commercial buildings including heating options

An overview of each of the above technical options, together with a general indication of expressed community interest is presented below. A detailed assessment of each option is presented in Part B.

- 2.2.1 New Housing:** New, more comfortable and energy efficient housing is clearly one of the top priorities in all communities. Several communities are already incorporating measures such as pressure treated wood crawl spaces and 2 x 6 construction into new housing. There is definitely a desire, however, for basic new house designs which incorporate all current energy efficient building techniques as well as features which generally make

housing more compatible with northern lifestyles and increase the expected life of buildings.

The new housing features most commonly mentioned during the community discussions included:

- half or full basement instead of unheated crawl space to reduce structural damage due to building movement and to increase storage
- separate access and storage for wood to reduce wear in living areas
- better building air tightness (reduced drafts)
- better air circulation to ensure distribution of warm air and prevent collection of hot air near ceiling
- better wood burning stoves that provide more lateral heating and reduce wood consumption
- a 30 year design life
- unused space that can be converted later into additional sleeping areas
- a work area accessible from outside for small engine work, etc.
- a screened porch for summer use
- better quality windows
- locally produced log construction or wood exterior finish

There were only minor variations in desired features between communities.

As a result of the high level of interest in improved new housing, this option is accorded major emphasis. Four preliminary house designs have been developed and are presented in Section 3 of Part B.

- 2.2.2 Upgrading Existing Housing:** This option is generally considered to be a less important priority than new housing in most of the communities. All current houses, even those built within the past 5 years, have inadequate foundations and fuel handling arrangements. This leads to building movement, structural damage, and heavy wear on floors, walls, etc. The average life of a house is usually only 10 to 15 years.

Recommendations for upgrading the comfort and energy efficiency of existing houses include: improved attic air tightness and insulation; replacement or sealing of doors and windows; and replacement of inefficient barrel wood stoves with more efficient cast iron or steel stoves. These recommendations are presented in Section 4 of Part B.

- 2.2.3 Upgrading of Existing Band Buildings:** In two communities, improvements to the Band office are considered a priority. They are heavily used but their poor heating characteristics make them uncomfortable to work in. The common problem in these buildings is inadequate heating and warm air distribution systems. Specific suggestions for these buildings are presented in Section 5 of Part B.

The upgrading of other Band owned buildings was not generally rated highly by the community. Although specific reasons varied between buildings, in general one or more of the following were cited:

- . a new replacement building was being planned
- . the building was heated only on a sporadic basis
- . the building used only a modest amount of wood fuel for heating and the cutting and provision of the wood provided a source of local income

2.2.4 Upgrading of School Buildings: The school facilities in Sachigo Lake, Bearskin Lake, and Weagamow Lake are approximately 15 years old and are similar in design. Newer facilities have been built in Cat Lake, Muskrat Dam and Slate Falls. All communities are experiencing a growth in the student population leading to the building of an extension at Bearskin Lake, the building of an annex in Sachigo, and plans for new schools in Sachigo and Weagamow.

Under the move to self government, it is expected that the school facilities will become a Band responsibility. The quality of education and school facilities are obvious concerns in all communities. There is moderate interest therefore in the upgrading of insulation, airtightness and heating systems in existing schools.

Based on a detailed check of the school building in Sachigo, recommendations on air tightness and insulation improvements were developed and are presented in Section 6 of Part B.

2.2.5 Substitution of Wood for Oil in School Heating Systems:

There is considerable interest in most communities in the possible sale of wood to schools and other buildings which install wood or combination wood/oil heating systems. In the new Muskrat Dam school a wood/oil furnace is already in use. In the Slate Falls school, a new energy efficient wood stove is the only heating system. Schools in Sachigo Lake, Bearskin Lake, and Weagamow Lake are heated with relatively old oil fired boilers which DIAND has identified for near term upgrading and/or replacement.

In Cat Lake, newer oil fired furnaces are used which could be supplemented with wood furnaces.

This option was rated highly, not only by the communities but also by the local school principals and by the operations and maintenance staff of DIAND's district office in Sioux Lookout. Consequently, this option was accorded major priority. It is presented in detail in Section 7 of Part B.

2.2.6 Heat Recovery from Institutional and Community Power Systems: The two major operators of diesel power systems in these communities are DIAND (school facilities) and Ontario Hydro (community power).

DIAND diesel power systems are located in Cat Lake, Muskrat Dam and Slate Falls. None of these sites provides a cost-effective opportunity for recovering diesel waste heat for space heating of the school facilities:

- all DIAND diesel engines are air-cooled; therefore, the amount of useable heat is restricted to only exhaust heat;

- . low electrical loads, as recorded during the site inspection of DIAND's Cat Lake diesel facilities, mean further reductions in the amount of recoverable heat;
- . at each of the sites inspected, DIAND's diesel sets are located too far away from school buildings that could use the heat;
- . there is the possibility of Ontario Hydro community power displacing the DIAND diesel sets in Cat Lake and Muskrat Dam within 5 years; and,
- . the school diesel generator in Slate Falls is too small to provide useable waste heat.

Most of the interest in waste heat recovery in the communities is therefore directed towards use of the waste heat from Ontario Hydro community power generators for the heating of new Band facilities. In several communities there are plans to locate new facilities sufficiently close to community power systems to consider installing a waste heat recovery system.

Specifications for a waste heat recovery system designed to recover heat from a typical Ontario Hydro system were developed under this option and are presented in Section 8 of Part B and in Appendix C.

2.2.7 New Commercial Buildings: Most communities are planning new facilities. These include: a garage, a warehouse, a craft workshop/display area, a community economic development centre, co-op stores, and schools. In most cases, detailed specifications are not yet available. Therefore, general recommendations on energy efficient building techniques and heating systems, along with some

specific suggestions for individual buildings (where appropriate) were developed and are presented in Section 9 of Part B.

2.3 Community Objectives and Priorities

Table 2.1 presents a summary of the priorities assigned to each of the above options by each community. A scale of 0 to 5 is used; 5 indicates highest priority and 0 indicates no interest. The priorities assigned serve to emphasize the high level of concern given to more comfortable homes and buildings and to employment creation.

Table 2.1
COMMUNITY PRIORITIES

Community	New Housing	Exis- ting Housing	Band Comm- ercial Bldgs	School Insul- ation	School Wood Heating	Diesel Waste Heat	New Comm- ercial Bldgs
	(A)	(B)	(C)	(D)	(E)	(F)	(G)
Sachigo Lake	5	1	2	3	5	1	4
Bearskin Lk	5	3	4	3	5	4	4
Weagamow Lk	5	2	4	3	5	4	4
Cat Lake	5	2	1	1*	4	3	4
Muskrat Dam	5	2	1	1*	5	3	4

* These are newer schools.

PART B**TECHNICAL OPTIONS: DETAILED
ASSESSMENT AND IMPLEMENTATION PLAN****INTRODUCTION**

Part B presents a detailed assessment and implementation plan for each of the previously identified technical options:

- . New Housing
- . Upgrading Existing Housing
- . Upgrading of Existing Band Buildings
- . Upgrading School Buildings
- . Substitution of Wood for Oil in School Heating Systems
- . Heat Recovery from Community Power Systems
- . New Commercial Buildings

Each option is presented within a common format consisting of:

- . Description of Current Situation
- . Description of Option
- . Technical Details
- . Estimated Costs and Savings
- . Impacts
- . Implementation Plan
 - Overview
 - Sequence of Steps
 - Project Management
 - Skills/Technology Transfer Required
 - Funding

SECTION 3

NEW HOUSING

3.1 Description of Current Situation

New housing currently being built in Sachigo and other Windigo communities follows standard 2 x 6 construction with 2 to 4 bedrooms, living room kitchen/dining rooms, and a small bathroom. Houses rest on piers or a wood frame crawl space which is unheated and uninsulated. Walls, ceilings and floors contain up to RSI 3.8 (R20) insulation. Vapour barriers are applied in the standard fashion after walls and insulation have been installed. Heating is provided by a barrel or airtight wood stove. There is commonly no water or sewage system. Outside dimensions are about 8 metres by 10 metres. Windows are usually double glazed vinyl framed units with horizontal sliders. Doors are wood in wood frames. The interior finish is usually wood panelled walls, ceiling tile, and vinyl floor tile. The exterior finish is usually wood or masonite based siding with asphalt shingle roofing. Electricity when provided is a 20 amp service. The life expectancy of current new housing is about 10-15 years. Most housing is site-built from materials shipped from Winnipeg. There is some experimentation in Bearskin Lake, however, with partially prefabricated houses built in Timmins, Ontario.

The major concern with current new housing is its short life expectancy. The factors which most affect this short life expectancy are:

- shifting foundations which cause structural damage

- location of the wood stove in the center of the home with no wood fuel access or ash disposal except through living areas
- the general lack of storage and working space for small machinery, etc.
- use of poor quality windows and doors which deteriorate quickly.
- inadequate ceiling vapour barriers can cause ice buildup, and water damage in the attic

A second concern is the lack of comfort in some parts of the house. Inadequate vapour barriers and poor quality windows and doors cause drafts, windows are not sized and located to take advantage of solar gain, and barrel wood stoves do not radiate heat horizontally very well. The houses were designed for forced air heating and with a central wood stove there are often cold drafty areas in one part of the house while heat collects near the ceiling in others.

A third concern is the small amount of local materials that go into the new housing. All materials are ordered through suppliers in Winnipeg. With shipping costs at about 9¢/Kg to Pickle Lake by road and about 90¢/Kg from Pickle Lake to Sachigo by air or winter road, there is an additional cost of \$16,000 for the 16,000 Kg of material required for each home.

3.2 Description of Option

Final designs for new housing should obviously be worked out between the Band, the new occupants and an architect/-designer. As an interim measure, however, several basic house designs were developed which overcome many of the shortcomings of existing housing, and incorporate other features identified during the discussions in Sachigo and other communities. These basic designs could be used for several experimental houses.

The new features incorporated into these house designs are as follows:

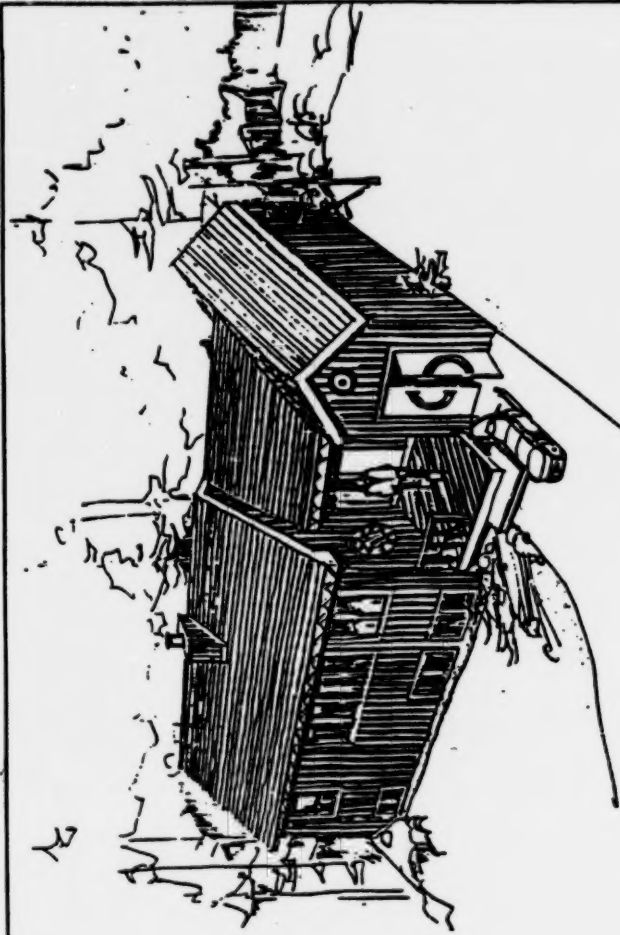
- a full basement or insulated crawl space that provides a firm foundation and also provides storage, work areas, and additional bedroom space as required
- an entry, wood stove, and basement stair arrangement that minimizes the distance wood has to be carried to the wood stove while maintaining the stove centrally in the living area
- an efficient wood stove that burns less wood, produces less ash, and radiates heat laterally
- a low powered circulation fan that can move warm air from the ceiling and wood stove areas to other parts of the house within the 20 amp service limitation
- storage and work areas for snowmobiles and other equipment attached to the house and accessible at grade level but separated from the house by an entry porch to provide a firebreak

- . wood frame windows with sealed double or triple thermopane glass and tight sealing opening sections or separate vents
- . a double door entry with insulated steel or wood door units with heavy duty weatherstripping
- . a continuous sealed vapour barrier throughout the whole house to minimize unwanted air infiltration and prevent ice moisture buildup in attic spaces
- . an air inlet arrangement to provide combustion air to the wood stove
- . an exterior finish of locally produced board and batten siding
- . lightweight steel roofing instead of heavy asphalt shingles
- . pressure treated wood foundations for heated crawl spaces and full basements
- . insulation levels to at least R30 in walls and basement, and at least R40 in the ceiling
- . single truss roof design to enable continuous ceiling barrier to be installed before interior walls
- . "curtain" wall method of providing additional wall insulation after structure has been closed in
- . living and dining room windows sized and oriented for

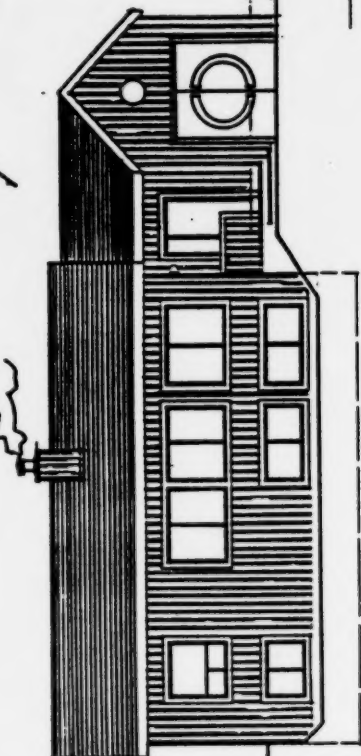
- . options for a screened summer porch and a lean-to for green wood storage and drying
- . options for use of basement or attic (loft) areas for additional bedroom space

3.2.1 Four New House Designs: The four new house designs are shown in Exhibits 1 to 4. House designs #1, 2 and 3 were developed by Marbek in conjunction with Shelter Construction and Development Ltd. House design #4 is an existing design developed by Solarctic Inc. Both firms have extensive experience in energy efficient northern housing design and construction. The four house designs incorporate all of the above features as well as the accumulated experience of the designers with energy efficient northern housing construction.

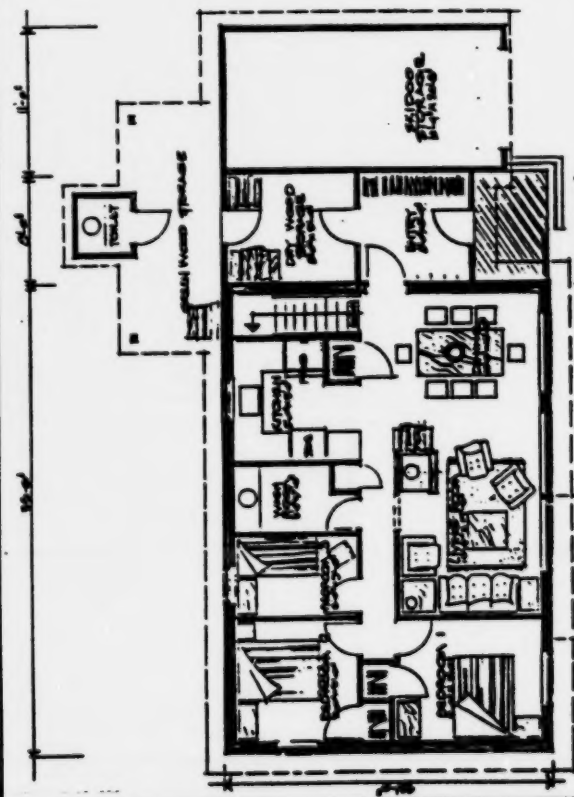
HOUSE #1 is a 3/5 bedroom design that can be built with either an insulated crawl space to give a 3 bedroom arrangement or a full basement to give a 3/5 bedroom arrangement. In the full basement option the house can be built with 3 bedrooms and expanded to 5 bedrooms as required. Entry is through a large porch which is also attached to a garage and wood storage area. The entry is arranged so that access to the basement does not require walking through the house. The wood stove is also centrally located yet wood needs to be carried only a short distance. The house should be oriented so that the living room and dining room face south and take advantage of passive solar gain through the large windows. Central siting of the wood stove allows natural circulation of warm air to all parts of the main floor, yet easy access for loading and ash removal is provided. Any heating of the basement would be through a low powered fan which



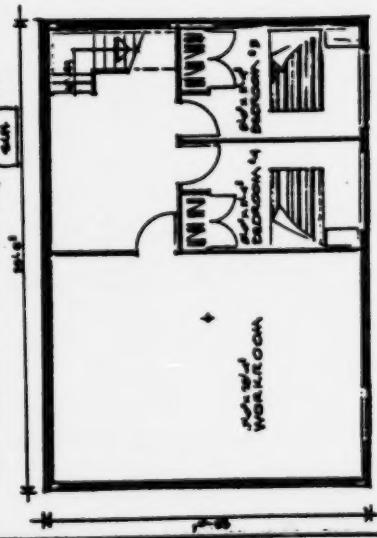
VIEW FROM THE SOUTH



SOUTH ELEVATION



MAIN FLOOR PLAN



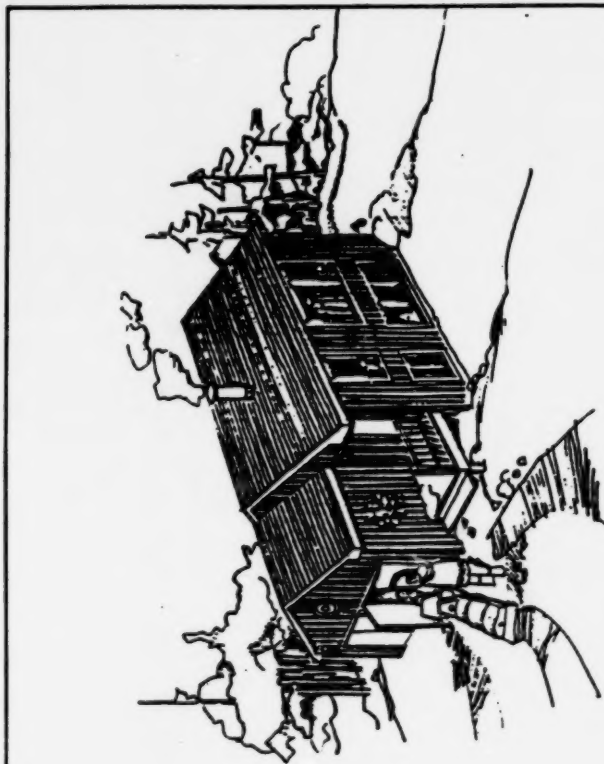
BASEMENT PLAN



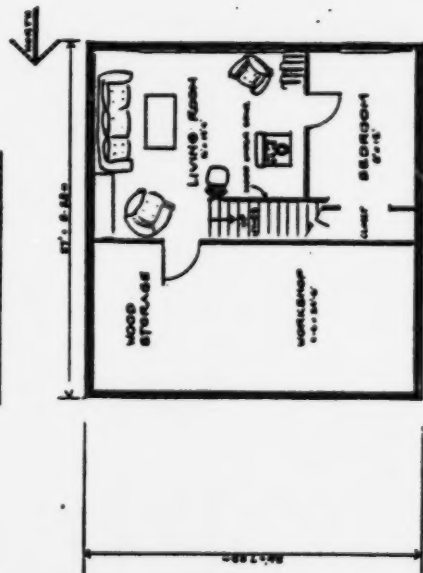
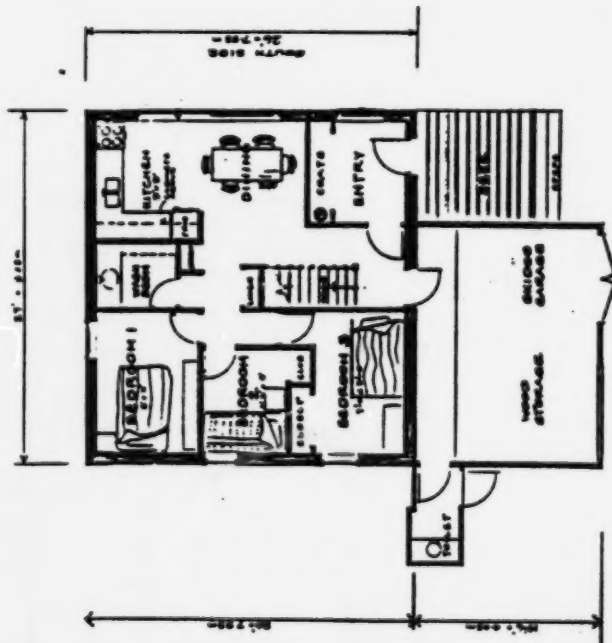
SHELTER
A Division of the National Housing Conference
Housing for the Homeless

SASHIGO LAKE HOLDINGS
FOR THE
WINDIGO
TRIBAL COUNCIL

DRAWN BY: J. J. JONES
HOUSE MODEL: **1**
SCALE: 1/8" = 1'-0"



VIEW FROM THE SOUTH



200 171 000 1000 1000



SHELTER
SHELTER FOR THE HOMELESS
1000 1000 1000

SASHIGO LAKE HOUSING
FOR THE
WINDIGO
TRIBAL COUNCIL

DATE: FEB 1988
HOUSE MODEL: 2
SCALE: 1/4" = 1'-0"

2

DATE: 11-1-78
DRAWN: J. L. JONES



SHELTER
FOR THE
TRIBAL COUNCIL

SASHOOL LAKE HOUSING
FOR THE
WINDIGO
TRIBAL COUNCIL

HOUSE MODEL **3**

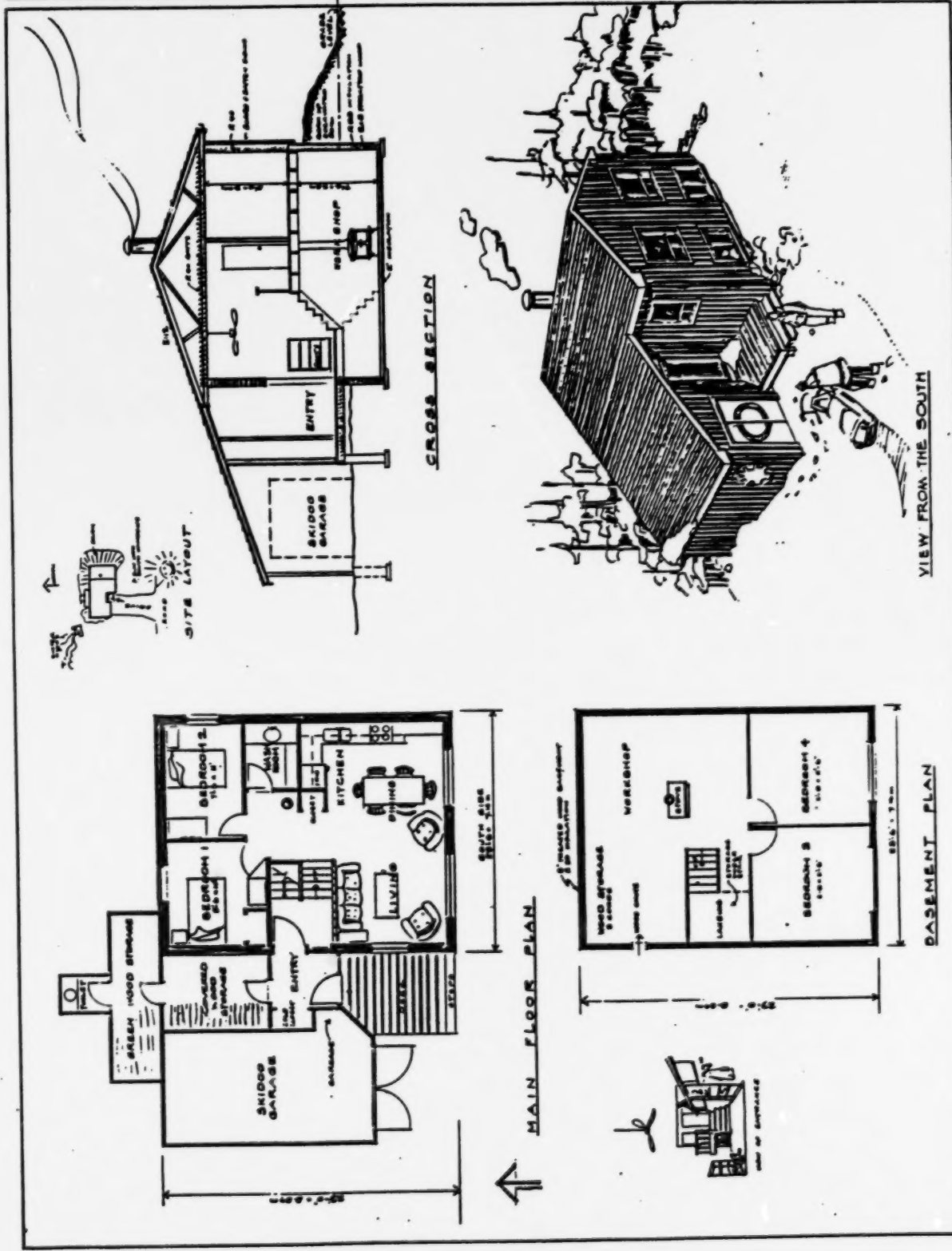
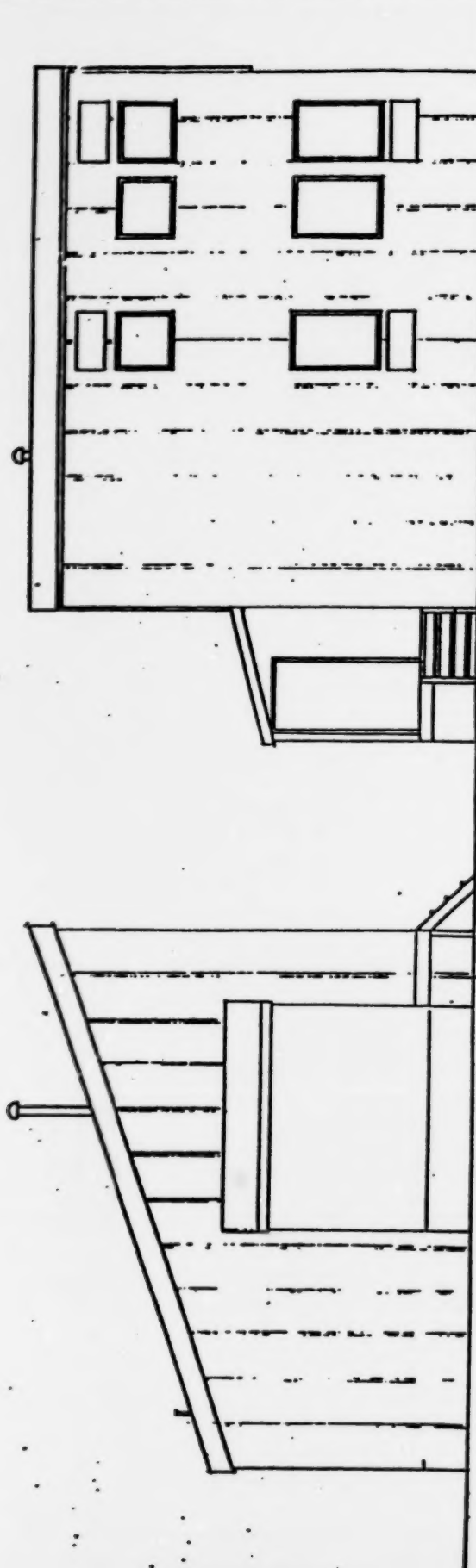


Exhibit 4



WEST ELEVATION

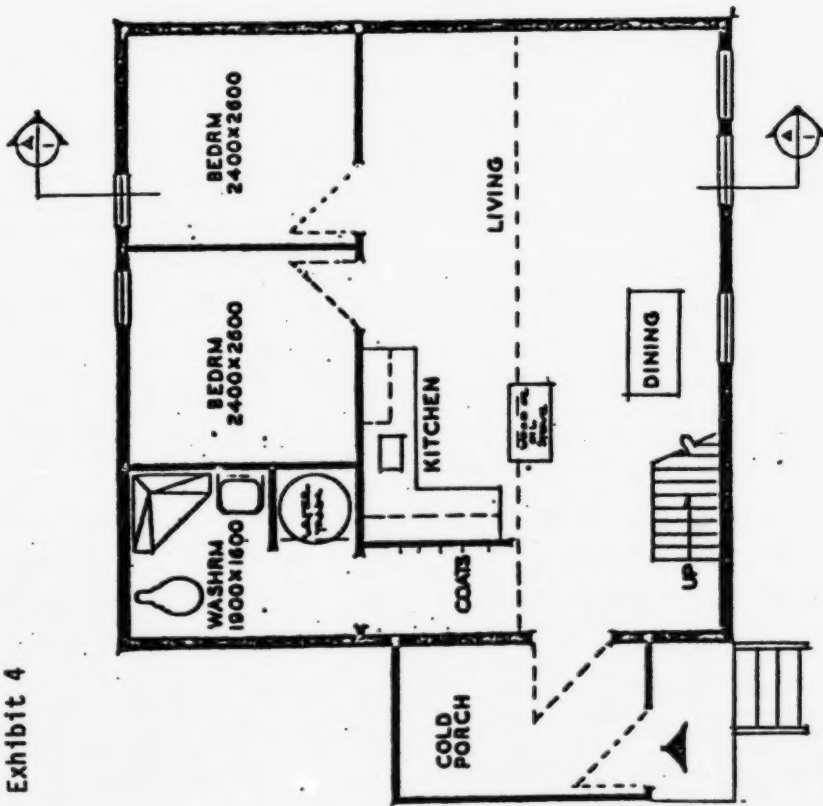
SOUTH ELEVATION

SOLARCTIC

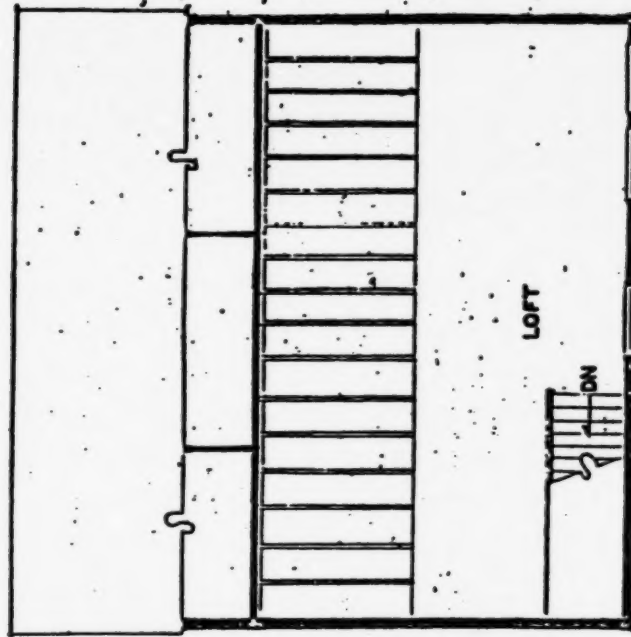
energy conscious housing Inc.

107 FOURTH AVENUE, OTTAWA, ONT
K1S-2L1 (613) 234-1593, 230-1489

Exhibit 4



MAIN FLOOR
7200 sq. ft.
52 m²



LOFT AREA

SOLARCTIC

energy conscious housing inc.

107 FOURTH AVENUE, OTTAWA, ONT
K1P 1H4

the stove and circulate warm air heated by the stove or solar gain down through the wall to the basement. A portion of the basement would be above grade to provide windows in the basement rooms.

HOUSE #2 is a compact 3/4 bedroom house with the living room and wood stove in the basement. As in House #1, entry is through a large porch with attached garage/wood storage and outhouse. The arrangement of the basement stairs, wood stove and porch allows access to the basement and stove without walking through the rest of the house. Solar gain would be through windows in the kitchen/dining room and the basement living room. Location of the stove in the basement would result in both the basement and main floor being heated by natural air circulation. Floor vents would allow adequate natural air movement. A screened porch could be built over the entry porch.

HOUSE #3 is a 2/4 bedroom house with full basement in which a wood stove, located in the basement, is used for heating. All living space except for 2 bedrooms is on the main floor. Entry is through a large porch which is located split level between the main floor and basement. Wood for the stove has only to be carried down half a flight of stairs and thus does not disturb the rest of the house. The wood stove used could be a semi-automatic unit that has several hours burning capacity and a built-in fan (low speed) for warm air circulation to the rest of the house. As in Houses #1 and 2, a garage/wood storage area is attached to the entry porch. The living room and dining room would normally face south to capture solar heat gain through their large windows. The basement could be used for extra bedroom space as required as well as as a storage/workshop area. A portion of the basement would be above grade to provide windows in basement bedrooms.

HOUSE #4 is a 2 bedroom house with a second storey loft area that could sleep two extra people. It is set over an insulated crawl space and has a large entry porch. It has an inside chemical or composting toilet instead of an attached outhouse. Unlike Houses #1, 2 and 3 which have conventional roof trusses and small attic spaces, House #4 has a shed roof design to incorporate the loft sleeping area. The wood stove is located centrally to provide natural heat circulation to all parts of the house yet is close enough to the entry to provide easy wood access and ash removal.

3.3 Technical Details

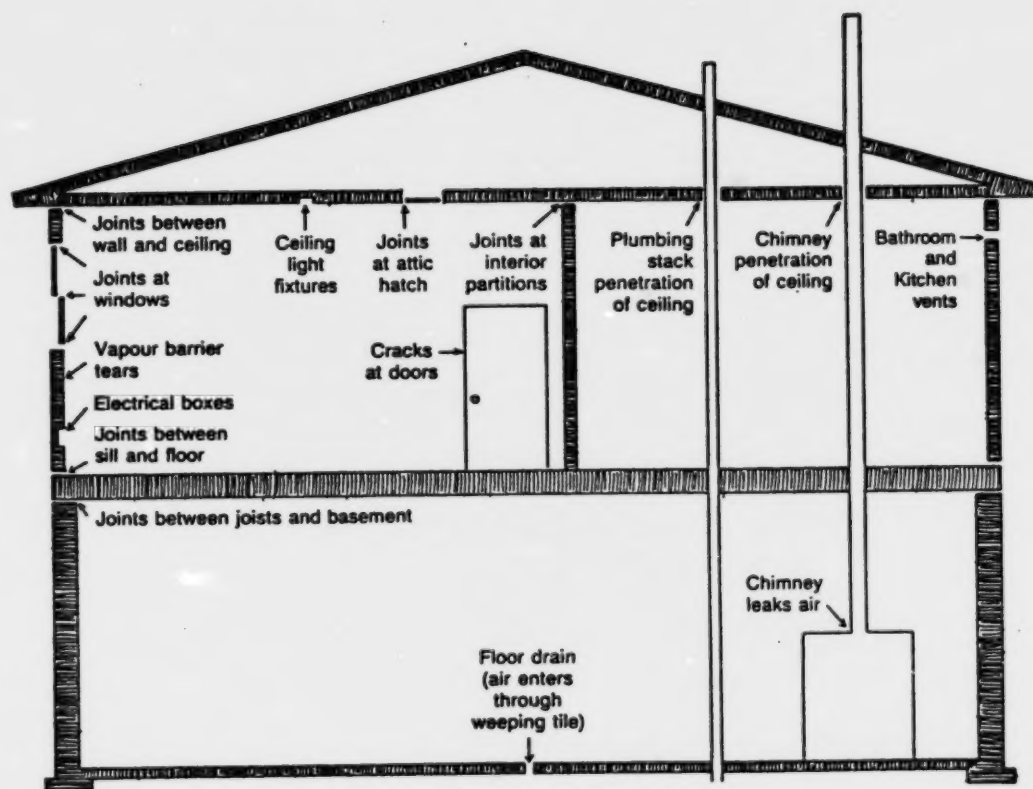
Energy efficient housing incorporates both new designs and new construction techniques. Some of the more important construction techniques are presented below.

- 3.3.1 Vapour Barrier:** All four houses are designed to use one of the current techniques for air sealing that reduce drafts and energy consumption by up to 80% over conventional housing. The main difference between energy efficient and conventional housing is that a continuous unbroken plastic vapour barrier is installed around the house during construction of the floors, walls, windows, doors and roof, rather than individual sheets of vapour barrier being attached after construction of the house. When the vapour barrier is attached after construction, air can move into and out of the house around windows and doors, and where floors, walls, and ceilings meet. The main points of air leakage in a conventional home are shown in Figure 3.1. Although each leak may be small, in total they can account for up to 30% of house heat loss

and make each room uncomfortable and drafty. With a continuous vapour barrier installed during construction, the house in effect becomes completely wrapped in plastic. This almost eliminates air leakage and allows much higher levels of insulation to be used.

Some of the techniques used in energy efficient house construction to achieve a continuous vapour barrier include:

- Attaching strips of vapour barrier to the edges of windows and doors before installation and sealing these strips to the exterior wall vapour barrier after installation (see Figure 3.2).
- Attaching a vapour barrier around floor joists and interior walls where they meet the exterior walls during construction and sealing it to the exterior wall vapour barrier after construction (see Figure 3.3).
- Use of full width roof trusses without interior bearing walls so that the ceiling vapour barrier can be installed before interior walls are built.
- Constructing the walls in such a way that there is a framework and insulation inside the vapour barrier as well as outside so that electric wiring, switches and receptacles can be installed without breaking the vapour barrier (see Figure 3.4). Note that there must be at least twice the thickness of insulation outside the vapour barrier as there is inside to prevent condensation of moisture and damage to the insulation and wall.

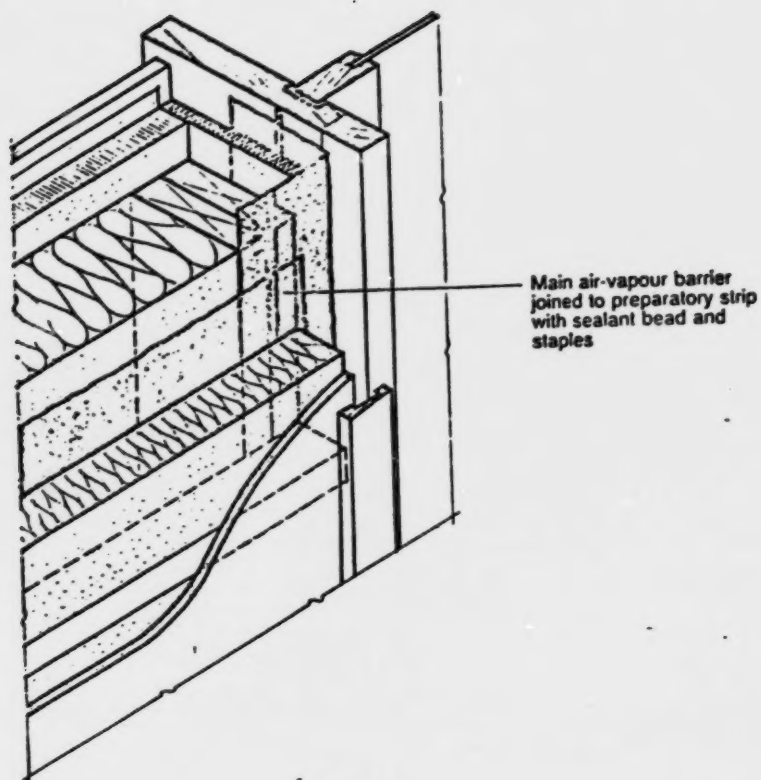


* Figure 3.1

Air leakage points in a conventional house

* Source: Home Energy Guide Vol. 2. No. 9, Winter 1983, p. 79
Fennwood Publishing, Scarborough, Ont.

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* Figure 3.2

Installing air vapour barrier to window frame

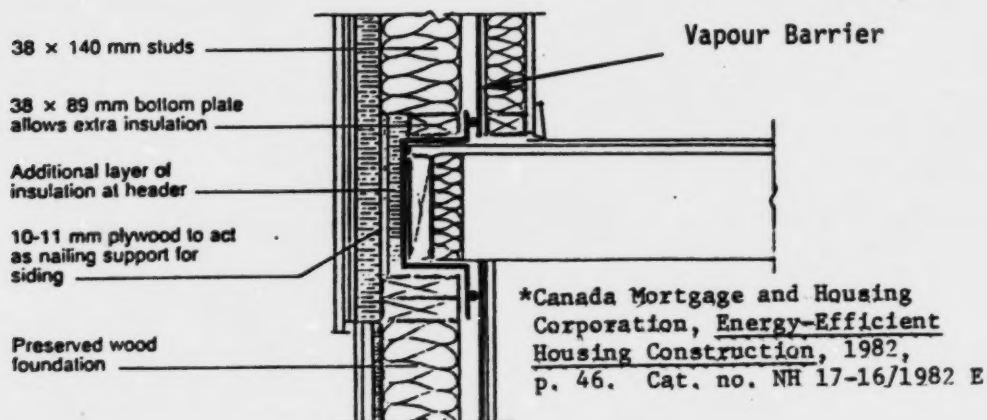
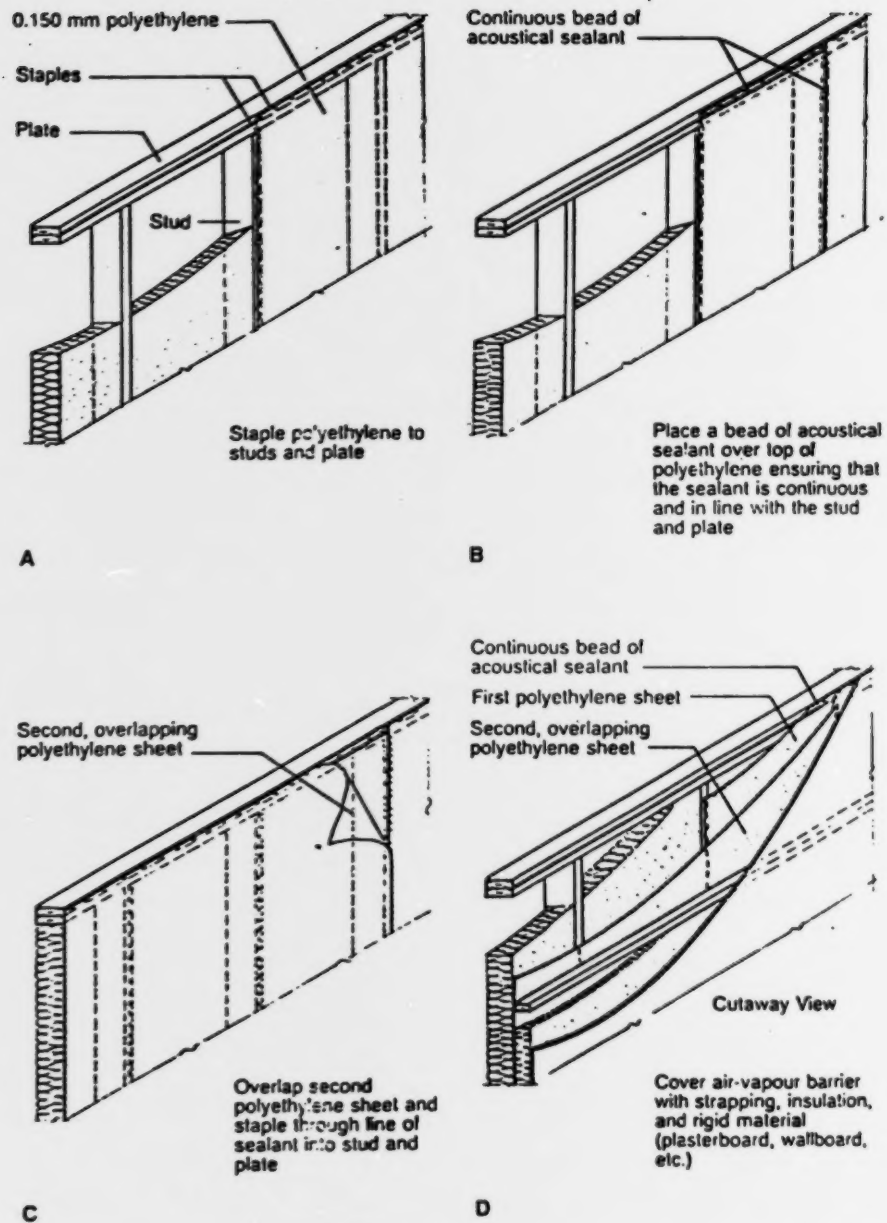


*Figure 3.3

Installing air vapour barrier around header



* Figure 3.4
Sealing Air Vapour Barrier

* Source: Ibid. pg.23

- Use of a high solids butyl rubber or acoustical sealant as well as a staple gun to seal overlapping pieces of vapour barrier along their whole length.

Once these techniques are learned by a construction crew, the time taken to frame and insulate an energy efficient house is much the same as the time taken to frame and insulate a conventional home. Some extra time will be required to build the additional wall framing (see Walls below) and there will be some extra material costs to cover the additional insulation, vapour barrier, wood framing and sealant. The total extra cost seldom exceeds \$2,000 to \$3,000 on a \$40,000 to \$50,000 house.

3.3.2 Walls: Because of the cost of shipping, an energy efficient building technique that minimizes the amount of additional structural materials is recommended for the four new house designs. Three types of wall construction are commonly used in energy efficient construction.

- Double wall in which two separate walls are built (see Figure 3.5).
- Frame with strapping in which extensive strapping is installed on the outside of a single framed wall (see Figure 3.6).
- Curtain wall in which a non-structural wall is "hung" outside a single framed wall (see Figure 3.7).

Frame with strapping tends to use the least amount of materials, followed by the curtain wall. A curtain wall however, is perhaps best suited for use with a wood frame (or log) basement (see Basement below) and is therefore recommended for the four new house designs. The wall

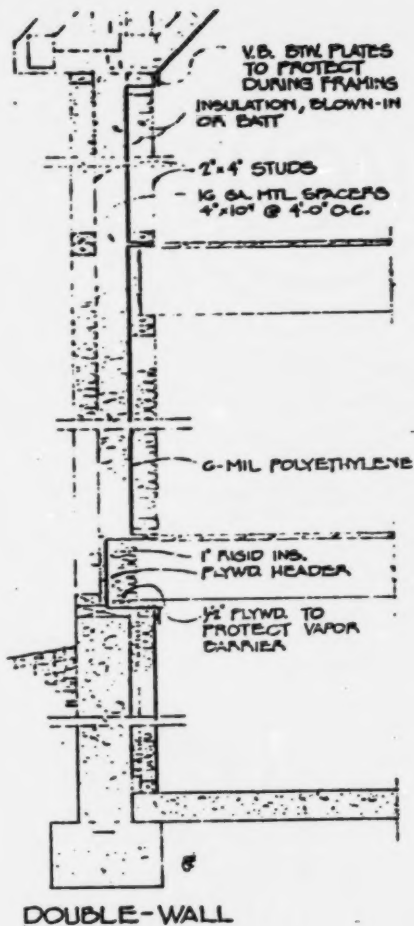
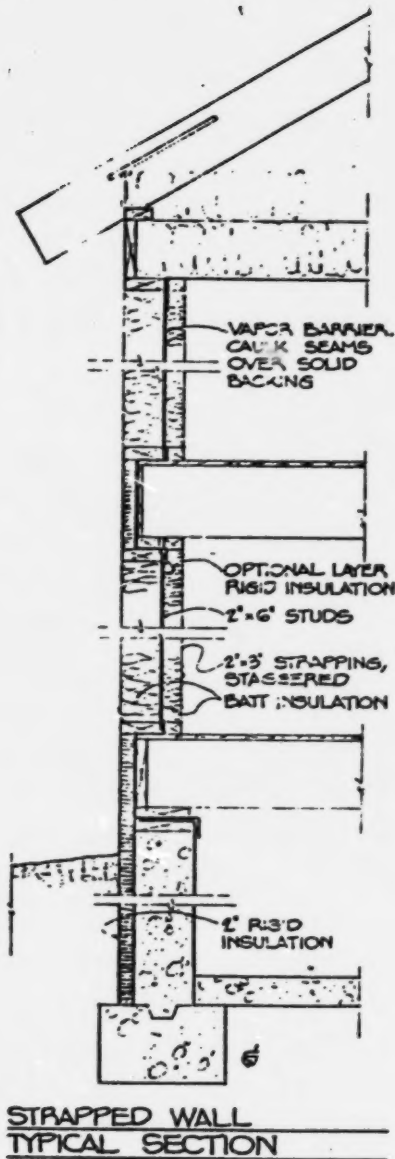


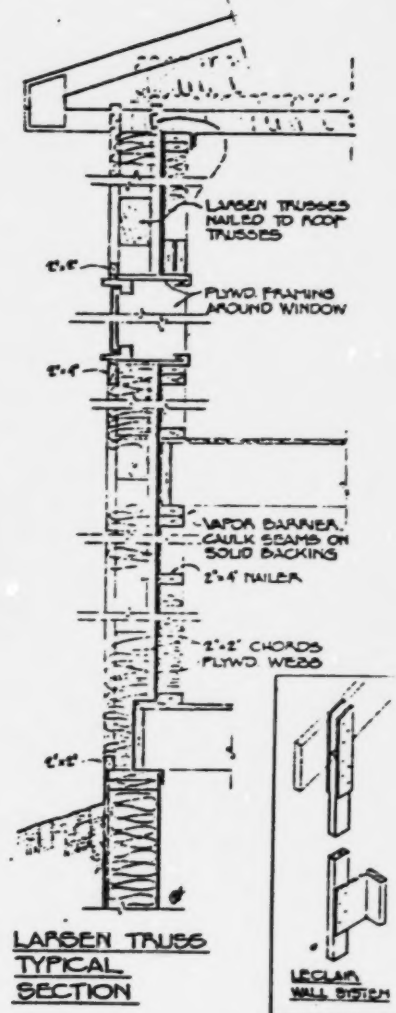
*Figure 3.5

Double wall construction



* Figure 3.6

Single wall and strapping



* Figure 3.7

Single and curtain wall

* Source: Solar Age, January 1984, Pg. 22,23.

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insulation level recommended is RSI 7 (R40). Inside finish would be wood panelling. Outside finish would be locally produced board and batten installed down to just above grade (see Exhibit 5). Windows should be high quality wood or aluminum frame double or triple glazed with sliding opening sections so that they can be operated in all weather. An alternative to an opening window is to have a ventilator section installed in the wall just below the window. Exterior doors should be purchased and installed as complete units that include insulated door (steel or wood), wood frame, and weatherstripping.

- 3.3.3 **Basement:** The high cost of shipping eliminates the possibility of using concrete basement wall foundations or floors. This leaves the option of using wood frame or log floors and foundation walls or a combination of the two. Wood frame foundations are usually built with pressure treated preserved wood to withstand the moisture present in the ground below grade. Experience has shown that a pressure treated wood basement is as structurally sound and durable as a poured concrete foundation wall. The wall is insulated and covered in the same way as frame walls above ground with a vapour barrier overlapped and sealed against the main floor vapour barrier (see Figure 3.8). The basement floor can be simply plywood or wood boards over floor joists whose ends rest on the wall footings which would be a flat 2 x 10 board on a gravel base. Underfloor insulation could be fibreglass between the joists, but it is recommended that rigid insulation set on a gravel base and covered with a layer of sand for fire protection be used instead because fibreglass will deteriorate if it becomes wet. An alternative to an all wood frame basement would be a combination log/frame basement (see Figure 3.9). Horizontal logs would be used for the walls below grade and for floor joists. A small pressure treated wood frame wall is set on the log wall

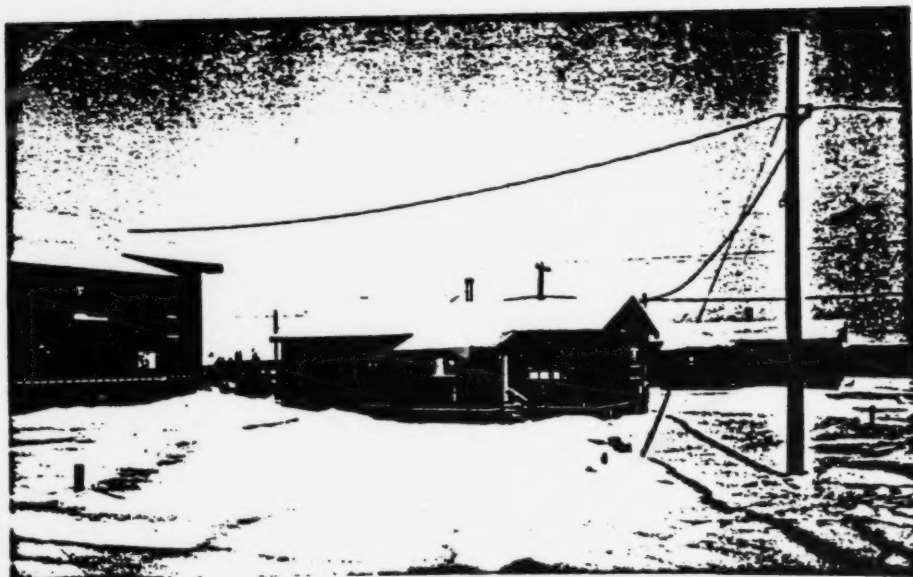
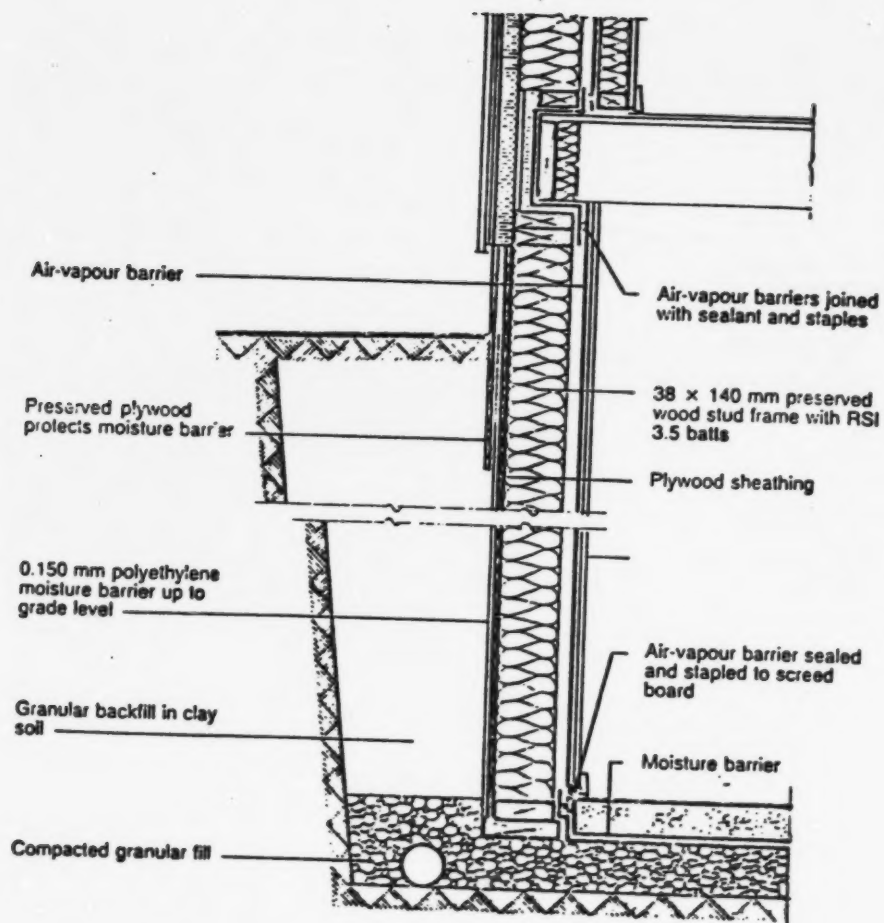


EXHIBIT 5

Photograph of Naskapi Housing



* Figure 3.8

Wood frame foundation

* Source: G. Matheson, op.cit. Pg. 38

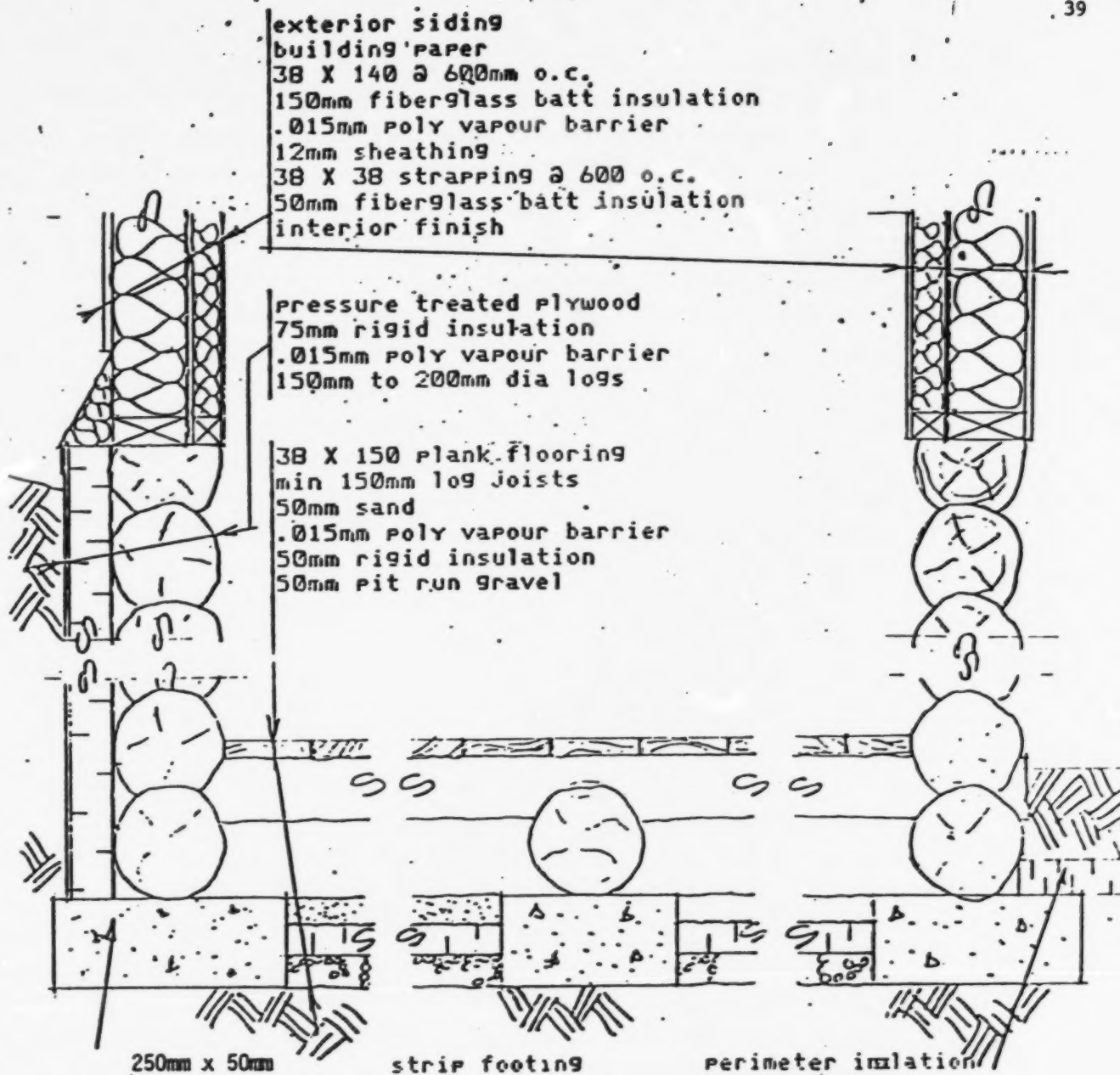


Figure 3.9

Combination log/wood frame
foundation -

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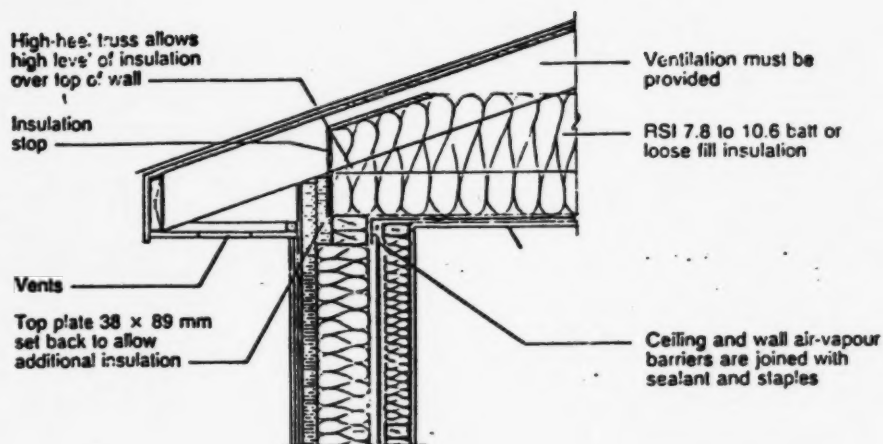
SOLARCTIC

energy conscious housing inc.
104 SECOND AVENUE OTTAWA, O.T.
K1S-2H5 (613) 234-593, 235-6945

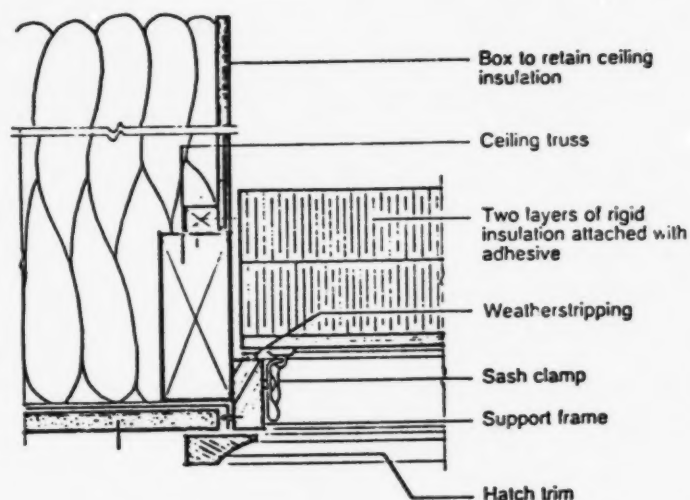
above grade. As well as increasing the amount of locally produced materials used in the construction, the log wall allows semi-controlled air infiltration necessary to provide combustion air for the wood stove in an otherwise sealed house (see Air Management below).

3.3.4 Ceilings/Roof: In Houses #1, 2 and 3, full roof trusses are recommended. These would be prefabricated on site and installed, before any interior walls were built. The roofing, ceiling insulation and vapour barrier would also be installed before any interior walls were constructed or the ceiling finish added. The recommended roofing is steel which is relatively light compared with asphalt shingles, is easy to install and can be purchased in several colours. Recommended ceiling insulation is RSI 10.5 (R60) fibreglass. Insulation stops or baffles would need to be added to allow free movement of air into the attic space along the length of the house (see Figure 3.10). An attic hatch would be placed over an intended hallway and insulated and sealed to prevent air leakage (see Figure 3.11). The section of the wood stove chimney which passes through the ceiling and roof would also be installed at this stage as would any kitchen or bathroom vent stacks (see Figures 3.12, and 3.13). Once the flooring, ceiling insulation, attic hatches, chimneys, vents and vapour barrier have been installed, interior walls can be built, a ceiling finish added (eg, ceiling tile), and the wood stove, etc. can be installed. In House #4 a similar procedure would be followed, except that I-beam or parallel cord trusses would be used for the sloped roof and ceiling. There would be no insulation baffles or attic hatch, and slightly less insulation RSI 7 (R40) would have to be used (see Figure 3.14).

3.3.5 Floors: Interior floors could be vinyl tile, wood (parkay) tile, vinyl flooring, or wood board. Wood board

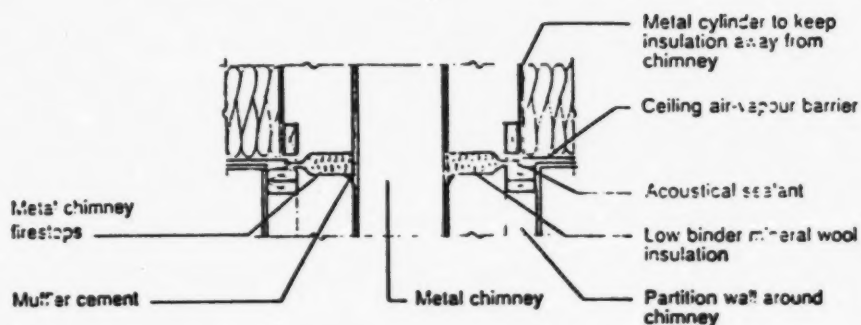


* Figure 3.10
Ceiling insulation

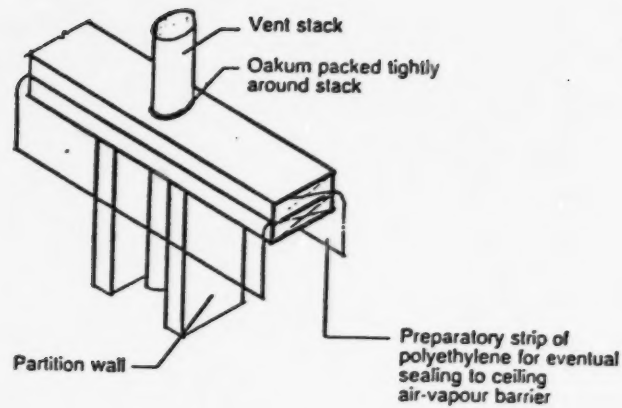


* Source: Ibid.
pgs. 54,56,57

* Figure 3.11
Attic hatch sealing and insulation

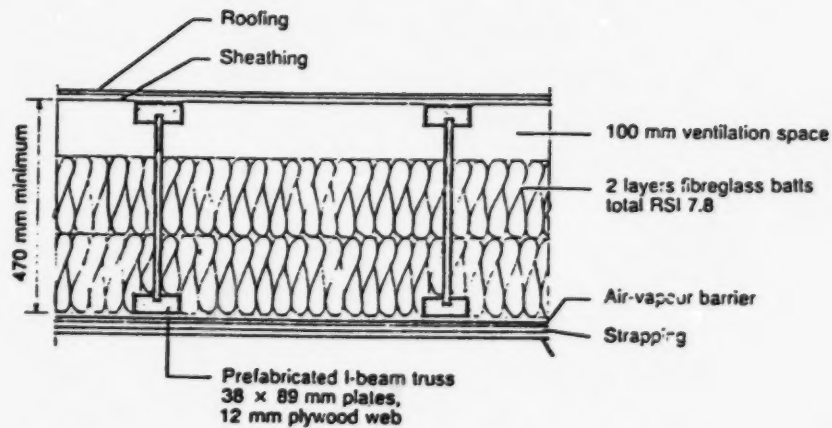


* Figure 3.12
Sealing and insulating around a metal chimney



* Figure 3.13

Sealing a vent stack



* Figure 3.14

I-beam roof truss

* Source: Ibid. Pgs. 57, 59

would increase the local materials content but would have to be planed if used in living areas.

3.3.6 Air Management: Any house that uses a wood stove or any other fuel burning heating system requires air for combustion. In a conventional house there is enough leakage into the house to replace the air used for combustion and exhausted up the chimney. In an energy efficient house, however, where all leaks are sealed, a controlled amount of outside air must be brought in or else the wood stove will not draw properly and could in fact introduce smoke and poisonous gases back into the house. Sealing all air leaks can also result in the buildup of moisture and condensation in energy efficient housing. The combination of the wood stove, kitchen or bathroom vents, and a controlled inflow of outside air, however, should result in enough air exchange to prevent moisture buildup. It is recommended that an air duct with damper, (which only allows outside air to be drawn in but not inside air to be lost), be installed to provide combustion air to the wood stove. The outside end would be located where it would never be covered with snow or otherwise blocked. The inside end would be located close to the stove's air intake, preferably where it could not be blocked. Because the use of outside air should obviously be reduced to a minimum, all wood stoves used should be of the airtight type. These stoves use only the precise amount of air needed for combustion and burn wood much more efficiently. It is also important to use the right size stove for the house. A well insulated sealed house will need a much smaller stove than currently used. Operating a too-large air-tight stove at very low capacity will cause creosote buildup and create a fire hazard, especially if green wood is burned. One of the advantages of having to use a small airtight stove, however, is that it will burn much less wood and therefore wood can be more easily dried before use.

3.4 Estimated Costs and Fuel Savings

The estimated materials and labour costs and shipping weight for the four new houses described are as follows:

	<u>Materials and Labour</u>	<u>Shipping Weight</u>	
House #1 (with full basement)	\$53,000	16,000 Kg	(35,000 lbs)
House #2	\$42,000	13,000 Kg	(29,000 lbs)
House #3	\$41,000	12,500 Kg	(27,500 lbs)
House #4	\$34,000	10,000 Kg	(22,000 lbs)

These costs and shipping weights are based on recent experience in building similar northern housing - \$6/m² (\$60/ft²) and 200 Kg/m² (40 lbs/ft²).

The heating costs for the four houses may be calculated as follows:

Assuming dry spruce has a heat content of about
18 GJ/cord,
Annual fuel use in cords of drywood

$$= \frac{\text{Annual heating requirements (GJ)}}{18 \times \text{Wood stove efficiency}}$$

The annual heating requirements are a function of the amount of insulation used, the size of the house, the

amount of air leakage, the amount of solar gain through windows, and of course the outside temperature during the heating season. The annual heating requirements of the four houses located in the Windigo area are estimated to be as follows:

House #1	21 GJ/yr
House #2	17 GJ/yr
House #3	15 GJ/yr
House #4	19 GJ/yr

These annual heating requirements were estimated using the computer program HOTCAN which determines not only the heat losses through the building envelope and because of air leakage, but also determines the amount of solar gain obtained through south facing windows and the amount of heat gains generated by occupants and appliances. These heat gains (solar plus occupant activities) can reduce fuel consumption up to 40% in a well-designed house. In calculating heating requirements, weather data and solar radiation for Big Trout Lake (degree days below 18°C of 7680) were used, and an air leakage rate of 1/3 air changes an hour was assumed.

Assuming a wood stove fuel burning efficiency of about 50% the annual dry wood requirements of the four houses should be as follows:

House #1	2.35 cords
House #2	1.9 cords
House #3	1.65 cords
House #4	2.15 cords

Given that current annual wood consumption for space heating is estimated to be in the range of 8 - 10 cords per house these results show that very significant fuel savings could be achieved through the introduction of energy efficient houses.

Appendix A presents the detailed results of the HOTCAN computer heat loss analysis for Houses #1, #2 and #3; these are the house designs developed by the Study Team. House #4 illustrates an alternative design, but, as stated previously, it was not developed by the Study Team. Heat loss data were provided by the designer and are based on previous analysis.

3.5 Impacts

The major impacts associated with the implementation of this option are outlined below:

- 3.5.1 **Social Impacts:** The principal social impacts would be more comfortable and functional housing as well as less time required for wood collection. However, it must be cautioned that the safe operation of efficient airtight wood stoves requires the use of dry (as opposed to green) wood and the regular inspection and cleaning of chimneys.
- 3.5.2 **Environmental Impacts:** As the proportion of energy efficient houses within the community grows, the overall demand on the community's wood resources will decline significantly. In addition, the reduced demand for wood for home space heating will mean that other options involving the substitution of wood for oil (ie, in schools) can be introduced without increasing the community's current annual volume of wood harvesting.

3.5.3 Economic Impacts: The principal economic impacts are:

- The extended design life of the new housing will mean that over time the number of replacement homes required will be significantly reduced. Particularly in the case of the move to self-government and the expected "block funding" approach, this will mean a significant increase in available funds for other community expenditures.
- Although local wood is "free", previous studies* have estimated that the cost of harvesting and transportation (ski-doo gas and deterioration, etc.) can be as high as \$50/cord. Thus, an annual reduction of 5 or 6 cords per household (new vs conventional house heat requirement) could result in an annual savings of \$250-\$300 per household.
- This option increases the feasibility of substituting wood for oil in existing institutional/commercial facilities. The harvesting and sale of this wood can provide permanent part-time local employment.

* Middleton Associates, Northern Community Energy Assessments, prepared for Kayahna Tribal Council, Ministry of Energy and Energy, Mines and Resources, September 1982.

3.6 Implementation

3.6.1 Overview: An architectural firm would be selected which has expertise in the design of energy efficient homes and experience in northern construction. This firm would provide final housing design(s) and would provide general contractor assistance. General contractor assistance would include materials and subcontractor specifications, as well as the on-site training of local carpenters in energy efficient building techniques. The on-site assistance of the selected firm's foreman would probably be necessary throughout the construction of the first 3 or 4 demonstration homes. Thereafter, the community's own carpenters/housing co-ordinators may be able to construct future homes independently, using the same basic designs and materials.

3.6.2 Sequence of Events:

Step 1 - Community Decision: The obvious starting point is the community's decision to pursue the construction of energy efficient rather than conventional housing. It is recommended that 3-5 units be constructed during the initial period. This will enable the "front-end" costs (see below) to be spread between several units, thereby reducing the incremental unit cost.

Step 2 - Select Architect/Building Firm: There are only a small number of firms in Ontario who have expertise in the design of energy efficient housing for northern communities as well as practical experience in constructing homes in northern native environments. Two of these firms have been named in this report. They are:

Shelter Construction and Development Ltd.
9 Lakeshore Drive
Toronto, Ontario
(416) 251-2115 and

Solarctic Energy Conscious Housing Ltd.
107 Fourth Avenue
Ottawa, Ontario
(613) 234-1593

Other firms with similar experience may be identified by contacting:

Conservation and Renewable Energy Office
Energy, Mines and Resources Canada
Room 606
55 St. Clair Ave. East
Toronto, Ontario
1-416-252-5866
Attention: Head, Energy Project Management

Step 3 - Form Project Management Committee: It is recommended that a project management committee be formed consisting of selected band representatives (particularly the housing co-ordinator) and the architect and construction foreman of the selected firm. This group would be responsible for:

- selection of final design(s)
- materials specification and procurement
- site development
- cost specification
- construction schedule and task allocation

Step 4 - Construction: Construction should ideally be carried out over the summer months. Assuming an early summer start-up, the units should be ready for occupancy in the fall. Local carpenters would work under the direction and supervision of the firm's foreman who would reside on site. The foreman would provide training to the local carpenters in energy efficient building techniques (as outlined in Section 3.3). Periodic site visits by the architect would provide "trouble-shooting" assistance as well as ensure that correct specifications were being followed.

Step 5 - Follow-up: After the initial houses have been constructed and local carpenters have become familiar with the new construction techniques, the Band may feel confident in its ability to build further homes without outside assistance. The designs and construction specifications developed for the initial homes may be sufficient for future construction. Alternatively, further assistance from the firm can be incorporated into the Band's construction plans.

3.6.3 Project Management: This is outlined in Step #3 above.

3.6.4 Skills/Technology Transfer Required: At present, new housing is constructed primarily by local carpenters and is managed by the band administration. Experienced carpenters and back-hoe drivers can be found in each of the communities. Consequently, the primary need, with respect to skills and technology transfer is in two areas:

- . the development of new housing designs (such as the examples provided in Section 3.2) and

- the training of local carpenters in the construction techniques which are unique to energy efficient housing

The energy efficient housing designs will be developed by the architect in conjunction with band members and the new construction techniques can be readily learned by the band's carpenters with the assistance and supervision of the construction foreman.

3.6.5 Funding: At this point, the need for, or extent of additional funding - beyond that already available through DIAND - is not certain. This need will only be clear after the Project Management Committee has selected the final design. Section 3.4 presented cost estimates for each of the 4 preliminary designs presented. Revisions to these designs may result in either upward or downward cost adjustments. Therefore it may be possible to cover the necessary design costs from within the existing DIAND allocation of approximately \$42,000/unit. Construction supervision costs are already included within the labour and materials costs presented in Section 3.4.

It is estimated that the architect costs for final design and construction specifications will be in the range of \$10,000 - \$15,000. However, if spread over 3-5 houses this represents a unit design cost of only \$2,000 - \$5,000.

In the event that additional funding is required to cover incremental unit costs beyond the approximately \$42,000 currently available, two possible sources other than DIAND have been identified. These are:

- Energy, Mines and Resources:

- Phase II of the Remote Community Demonstration Program (RCDP). Program and Funding information available from:

Conservation and Renewable Energy Office
Room 606
55 St. Clair Ave. East
Toronto, Ontario
1-416-252-5866
Attention: Head Energy Project Management

- Canada Mortgage and Housing

- Rural and Native Housing Program or Part 5 Funding Program. Program and Funding Information available from:

Canada Mortgage and Housing Corporation
Ontario Regional Office
Toronto, Ontario
(416) 498-7300
Attention: Program Officer

SECTION 4

UPGRADING EXISTING HOUSING

4.1 Description of Current Situation

As discussed previously, the life expectancy of current housing in the Windigo communities is 10 to 15 years. Older houses that are already seriously deteriorating because of shifting foundations, heavy wear, and the use of low quality windows, doors etc. may not warrant significant expenditures on upgrading. These houses should gradually be replaced with new more durable designs similar to those described in Section 3. On average, about 20% of the houses viewed, fell into this category. Other houses can benefit from some or all of the measures outlined below.

The largest interest shown in the upgrading of existing housing was in Bearskin Lake, where there are a significant number of homes in the 3-8 year age bracket. These houses are typically 7.25m x 9.75m (24 ft x 32 ft) single storey buildings built on uninsulated wood crawl spaces or piers. The main floor is 2 x 8 construction insulated to about RSI 3.6 (R20). The walls and ceiling are insulated to about RSI 2.1 (R12). Inside finish is wood panelling, vinyl floor tile, and ceiling tile. Outside finish is vertical wood based siding. Doors are solid wood in a wood frame. Windows are vinyl frame horizontal siding double pane units. In some of the homes, heating is provided by efficient airtight Fisher wood stoves; however, in many homes, inefficient barrel or light sheet metal stoves are still used.

The main sources of draft and air leakage appear to be through the doors, and the attic hatch. (There is

evidence of some ice buildup in the attic over the attic hatch). The attic vapour barrier also does not extend over the tops of interior walls resulting in some additional air leakage into the attic. The lack of a heated or insulated crawl space also probably results in air leakage around the bottom of exterior walls. The radiant heat airtight wood stoves appear to comfortably heat all parts of the house. Stove pipes however are often installed in the same way as oil stoves with the downward facing lip on the outside. This results in creosote leaking out on to the outside of the stove pipe.

Windows appear relatively draught free. However, ice buildup between panes is an indication that inside air is leaking out around the inner pane.

4.2 Description of Option

The recommended retrofit measures fall into three groups:

- upgrade attic insulation
- air sealing
- installation of efficient radiant heat airtight wood stoves

4.2.1 Attic Insulation: In consideration of the existing siting, construction type and levels of insulation in homes 3-8 years old, it is recommended that insulation levels be increased to about RSI 5.5 (R30).

4.2.2 Air Sealing: Air sealing should be the major focus of retrofit activities. Again, given the existing construction type and heating source, the primary focus should be the sealing of the attic space in order to prevent possible moisture damage, especially if the attic insulation is increased. Therefore the recommended air

sealing measures stress attic/ceiling channels of air leakage which are relatively straightforward and low-cost to apply. The second focus of air sealing measures should be those areas of air leakage responsible for uncomfortable draughts. This particularly applies to exterior doors and door frames and exterior wall receptacles.

Consequently, the recommended air sealing measures are:

- . Seal gaps between exterior doors and the door frame (replace door if badly warped)
- . Seal gaps between the exterior door frames and the surrounding wall
- . Seal electrical receptacles in exterior walls
- . Seal electrical receptacles in attic space
- . Seal attic hatch
- . Seal gaps between top plates of partition walls and the ceiling
- . Seal air leakage points around interior window trim

Application techniques for each of the above measures are presented in Section 4.3. In addition, where windows present an uncomfortable draught, it is recommended that plastic storms be installed on the interior not the exterior side, as appears to be most commonly practised. (Newly available, heat shrinkable plastic is recommended.)

Areas of air infiltration or exfiltration which require more complex procedures, do not threaten the structural integrity of the building (ie, moisture damage) or result in noticeable uncomfortable draughts can be left in their present state. This is not only because they are more difficult to detect and remedy but also because some air infiltration is necessary to provide combustion air to the wood stoves.

- 4.2.3 Installation of Efficient Stoves:** Many homes are presently using the old "barrel" type or light sheet metal stoves. The homes which were inspected by the study team were using Fisher stoves. These are a good quality stove and are an example of the type of stove which could be used to replace poor quality ones. Appendix B provides a partial list of other good quality, efficient wood stoves. In addition, the stove pipe for these stoves should be installed with the the crimped end down inside the next piece of pipe to prevent creosote leakage.

4.3 Technical Details

Most of the retrofit measures recommended above involve air sealing. Before presenting specific application techniques, it will be useful to briefly outline some of the principles of air sealing.

Air sealing is a relatively new specialization in building energy retrofit. Consequently, research is ongoing and new refinements in application procedures, and materials are continuing to emerge. Energy, Mines and Resources Canada has recently published the second draft of an extensive air sealing document entitled Air Sealing Homes for Energy Conservation. The following discussion of air sealing principles and application procedures is drawn from this recent publication and emphasizes only those aspects which are most important to housing in the Windigo Communities. (A copy of this publication has been provided to the Windigo Council for reference).

4.3.1 Principles of Air Sealing: The term "air sealing" is used here to refer to a systematic approach to stopping up the cracks and holes which allow for uncontrolled infiltration and exfiltration of air and moisture in homes. Many of these leakage points are not at all obvious.

The methods recommended for use in air sealing in Windigo homes include the application of sealants (ie, caulking) and weatherstripping. In both cases there exist a variety of materials and often alternative methods of application. In sections 4.3.2 to 4.3.9 materials and applications methods are recommended on the bases of both the present level of air sealing knowledge and practical considerations related to the often unique circumstances of remote community housing conditions and restricted access to materials. It should be noted that in all of the applications presented here, the air sealing materials are installed on the inner (warm) surface of the house.

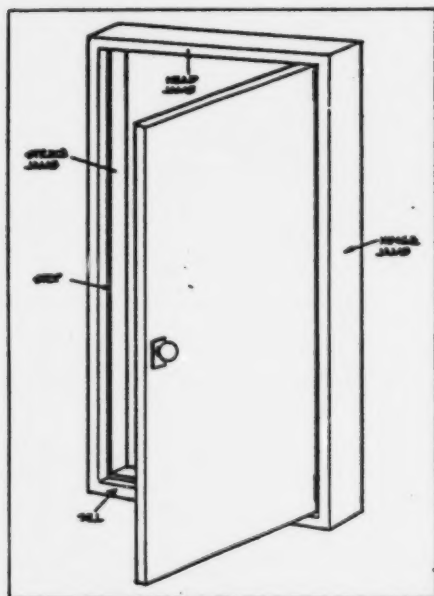
Air sealing is important because:

- Air leaks account for 20 - 50% of total home heat loss
- Air leaks decrease comfort by creating drafts and reducing winter household humidity levels
- Air leaks can lead to moisture damage problems; the undertaking of extensive reinsulation without adequate air sealing risks significant damage from trapped moisture.

Air sealing is now regarded as an important, and usually necessary, first step in the process of effectively retrofitting a home.*

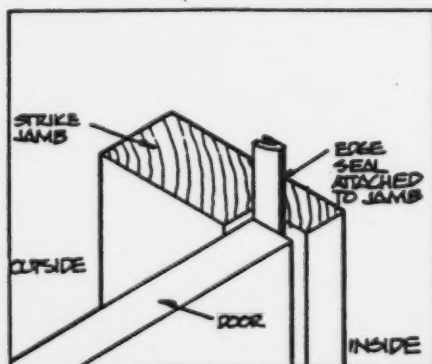
* Energy, Mines and Resources Canada, Energy Conservation and Oil Substitution Branch, Air Sealing Homes for Energy Conservation, Second Draft, Supply and Services Canada, 1984, cat. no. M92-6/1984E.

4.3.2 Sealing Between Exterior Doors and Door Frames: The "weatherstrippable" parts of an exterior door and frame are shown in Figure 4.1. Doors which are badly warped should be replaced.

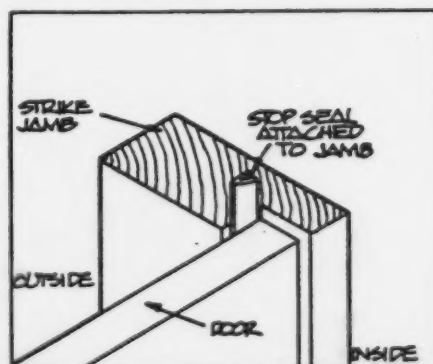


* Figure 4.1
"Weatherstrippable" Door
Components

Plastic V edge seals or stop seals are recommended for the strike, head and hinge jamb and should be applied in accordance with the manufacturer's instructions. Figures 4.2 and 4.3 show the proper application of the V edge seal and stop seal respectively, to the hinge jamb.



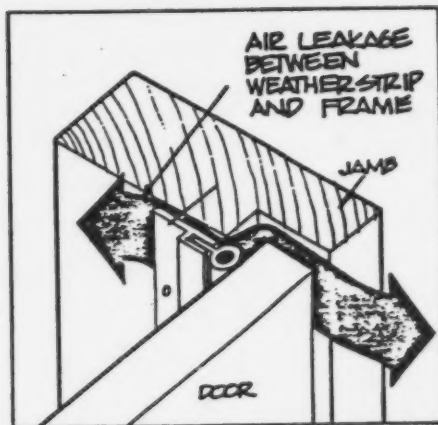
* Figure 4.2



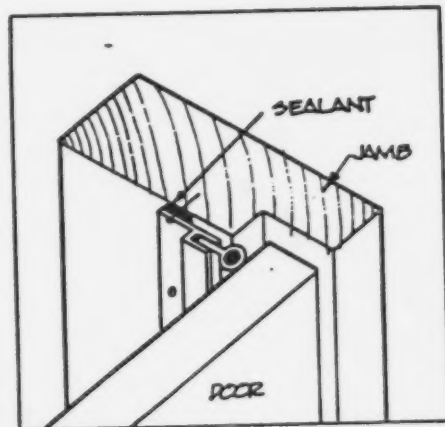
* Figure 4.3

* Source: Ibid. Air Sealing Homes for Energy Conservation
pgs. 13.12 and 13.13

When installed, some seals may not fit tightly to the jamb, leaving small gaps through which air leakage will continue (see Figure 4.4). This can be remedied by applying a fine bead of sealant to the jamb. The weatherstripping should then be installed over the bead as shown in Figure 4.5

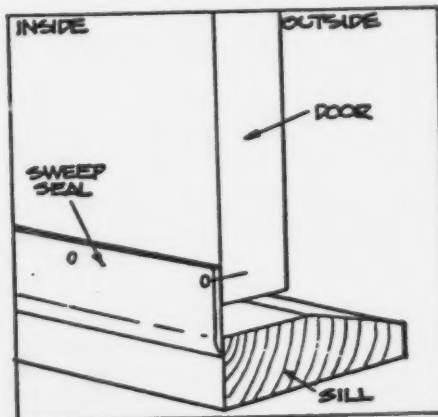


* Figure 4.4

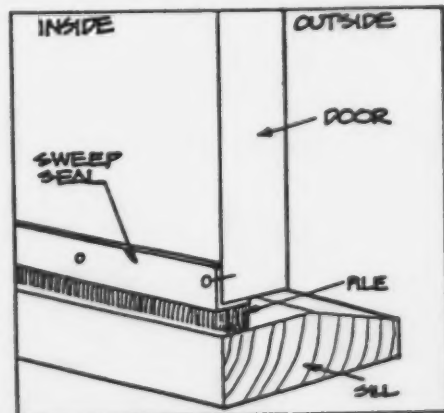


* Figure 4.5

A door mounted sweep weatherstripping is recommended for bottom sill sealing as shown in Figures 4.6 and 4.7.

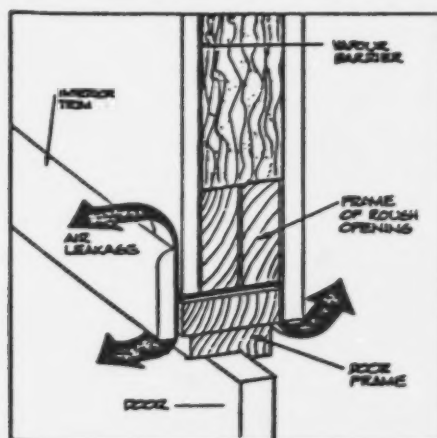


* Figure 4.6



* Figure 4.7

- 4.3.3 Sealing Between Door Frame and Wall:** Doors are set into rough openings in the wall frame. There is usually a gap between the door frame and the wall. Although this gap is concealed by the interior trim, it may be responsible for a large amount of air leakage (see Figure 4.8).



* Figure 4.8

Even if the gap is filled with insulation air leakage may be significant, as most insulation types do little to stop air leakage.

Exhibit 6 is an excerpt from the previously mentioned Air Sealing document and provides an outline of materials and application procedures.

EXHIBIT 6**SEALING BEHIND THE INTERIOR DOOR TRIM**

This Exhibit outlines techniques for removing trim around doors and sealing the gap between the door frame and the surrounding wall and floor.

PREPARATION

1. Where necessary, score the trim paint with a knife, in order to prevent paint from chipping and peeling when the trim is removed.
2. Remove the trim using pry bar. A piece of plwood should be used as a leverage surface for the pry bar to eliminate damage to the surrounding wall. Nails that resist removal can be punched through using a nail punch. After trim removal, any residual nails should be removed.
3. Inspect the gaps around the door frame. Where there are large, uninsulated gaps, work insulation into the gaps but do not compress. If the gap is greater than 25mm, urethane foam insulation may be used (if care is taken to allow for expansion of the foam).
4. Using MEK, clean the frame, surrounding wall, and floor around the sill, to remove dirt and grease. Remove any excess paint with a scraper. Prime if required, following the sealant manufacturer's instructions.

APPLICATION

1. Seal the gap along the head and side jambs, using one or more of the following techniques:
 - Where the gap between the frame and wall is less than 3mm, seal by applying a bead of silicone sealant to fill the gap.
 - Where the gap is 3mm to 6mm wide, insert a backer rod into the gap, to a depth not greater than 6mm. Then apply silicone

EXHIBIT 6 (continued)
SEALING BEHIND THE INTERIOR DOOR TRIM

sealant against the backing rod so as to make a good seal between the frame and wall.

- . Where the gap is wider than 6mm, it should be sealed with strips of 0.150mm polyethylene. The strip should be attached by running a bead of the acoustical or high solids butyl rubber sealants along both the door frame and the wall. Press the polyethylene strips into the sealant and staple every 150mm. Hammer the staples flush.

2. Inspect the seals. If the door has been sealed using more than one of the above options, make sure the seal is continuous where the techniques change.

3. Seal the gap between the sill and the floor with paintable silicone sealant. Make sure that this is worked well into the gap. Carry the sealant bead around the ends of the sill to make a continuous sealed joint with the previous work around the jambs.

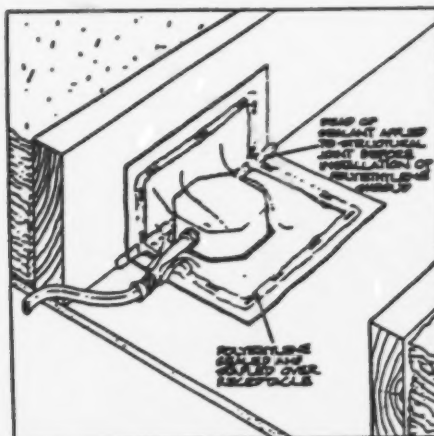
4. Reinstall the trim. Remove any protruding polyethylene or excess sealant.

Source: Ibid. pg 13.7

4.3.4 Sealing Electrical Receptacles in Exterior Walls: The electrical receptacles (switches and outlets) located in exterior walls can, together, account for significant air leakage. The technique for air sealing receptacles is straightforward and inexpensive. As outlined in Exhibit 7, the technique simply involves the placement of a CSA approved gasket behind each receptacle cover plate. These gaskets are inexpensive (under \$2 for a package of 6) and can be obtained from any building supplier.

It should be noted that nothing should be introduced into the receptacle that could lead to increased risk of fire.

4.3.5 Sealing Around Electrical Receptacles in Attic: Exhibit 8 outlines the polyethylene technique for sealing around electrical receptacles in the attic. This technique must be applied from the inside of the attic, but is otherwise straightforward. Figure 4.9 shows proper application of this technique. It should however be cautioned that it must not be used in conjunction with recessed pot lights. However it is not likely that this type of fixture will be encountered in the Windigo homes.



* Figure 4.9

* Source Ibid. pg 11.23

EXHIBIT 7

SEALING ELECTRICAL RECEPTACLES

This Exhibit outlines the techniques for installing gaskets and child-safety plugs to seal air leakage openings in electrical receptacles.

The gaskets are installed behind the receptacle cover plates, and must be CSA approved for this application. Note that some available gaskets are not CSA approved; these should be avoided.

The child safety plugs are a childproof plastic insert, which can be pushed into electrical sockets. This is a safeguard for children, but it is also useful in sealing off one type of air leakage opening in the outlet.

PREPARATION

1. Switch off all electrical supplies to the receptacles in exterior walls.
2. Remove cover plates from switches and outlets.
3. Repair surface around receptacles to provide a smooth base for the gasket. Use jointing cement or wood filler as required.

APPLICATION

1. Place gasket on the face of the receptacle. No special attachment procedure is required.
2. Re-install the receptacle cover plates.
3. Insert childproof plugs in little-used outlets.
4. Switch the electrical supply back on.

Source: Ibid. pg 11.22

EXHIBIT 8

SEALING AROUND ELECTRICAL RECEPTACLES

This Exhibit outlines the polyethylene technique for sealing around electrical receptacles in ceilings.

PREPARATION

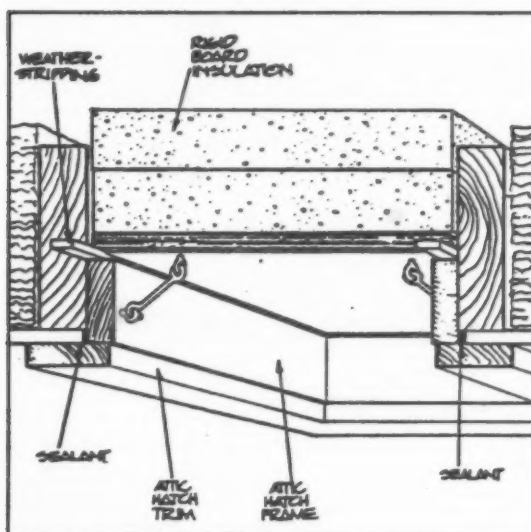
1. Remove insulation to give a clear working area around the receptacle.
2. Using a brush, remove all loose material from the working area.
3. Clean all surfaces to which sealant will be applied using MEK or mineral spirits. Do not apply MEK to electrical wiring.

APPLICATION

1. Inspect the area around the receptacle. If there are smooth working surfaces, this technique can be used.
2. Apply acoustical sealant along any structural joints that will eventually be covered by the polyethylene shroud.
3. Cut a piece of 0.150mm polyethylene, sized to fit around the receptacle as shown for one common situation in Figure 4.10. Slit the polyethylene to fit around any cables.
4. Fit the polyethylene around the cables and make a secure airtight joint by wrapping with several turns of duct tape. Seal the slit by overlapping the two edges, with a bead of acoustical sealant pressed in between. Secure the seam by stapling with a paper stapler.
5. Apply a continuous bead of acoustical sealant around the work area in a pattern such as that shown in Figure 4.10. Press the polyethylene to the sealant, and secure with staples.
6. Replace the original insulation.

Source: Ibid. pg 11.23

4.3.6 Sealing Attic Hatch: Figure 4.10 shows a properly sealed interior attic hatch. Exhibit 9 outlines the recommended application technique.



* Figure 4.10

* Source: Ibid. pg. 11.29

EXHIBIT 9

SEALING THE ATTIC HATCH

This Exhibit outlines techniques for the sealing of an interior attic hatch.

PREPARATION

1. If application of exposed sealant around the attic hatch trim is unacceptable to the householder, remove the trim using a pry bar. If necessary, before removal use a knife to score the paint from at the trim/ceiling joint, in order to prevent paint chipping and peeling.
2. Clean all surfaces to be sealed using a wire brush. Wipe with MEK.
3. Use a brush to clean the top of the framework that supports the hatch cover. If necessary, use sandpaper or a plane to provide an even surface. Wipe with MEK.

APPLICATION

1. If the attic hatch trim has been removed, apply a uniform and continuous bead of water-based acrylic or silicone sealant to the joint between the ceiling surface and the frame of the attic hatch, as shown in Figure 4.11. Re-install the trim using finishing nails.
2. Alternatively, if the trim has not been removed, seal the joints between the trim and the ceiling and between the trim and the attic hatch frame. In addition, seal the corner joints in the trim and in the attic hatch frame.
3. Apply a self adhesive closed cell foam weatherstripping material, or a plastic "V" weatherstrip, to the top surface of the framework which supports the hatch cover. Ensure that the corners of the weatherstripping fit tightly.
4. Glue a piece of rigid insulation to the hatch cover. Be sure to use an adhesive compatible with the insulation material. Alternatively, construct a wood frame around the hatch cover and install a glassfibre insulation batt within the frame. Cover the

EXHIBIT 9

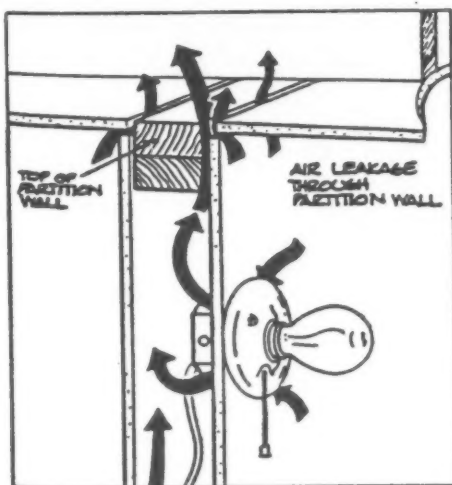
SEALING THE ATTIC HATCH

frame and insulation with a plywood top.

5. Attach some sort of clamp or lock to the hatch cover and frame as shown in Figure 4.11. The device, when installed, should be able to pull the hatch tightly into the weatherstripping material, thereby providing a better seal.

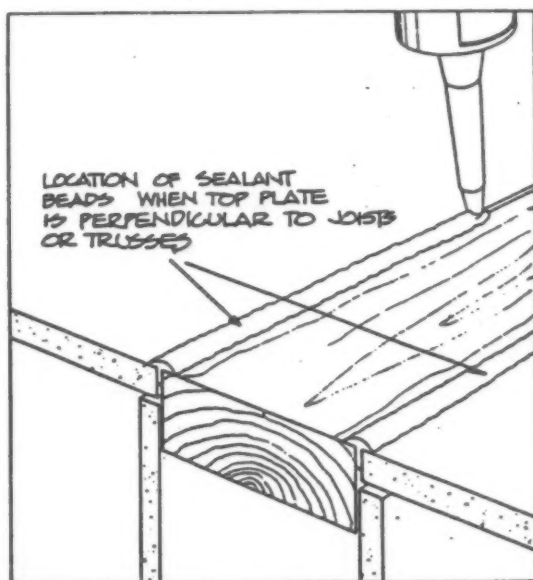
Source: Ibid. pg. 11.28

4.3.7 Sealing Top Plates of Partition Walls: Figure 4.11 shows the typical channels of air leakage at the top of interior partition walls.

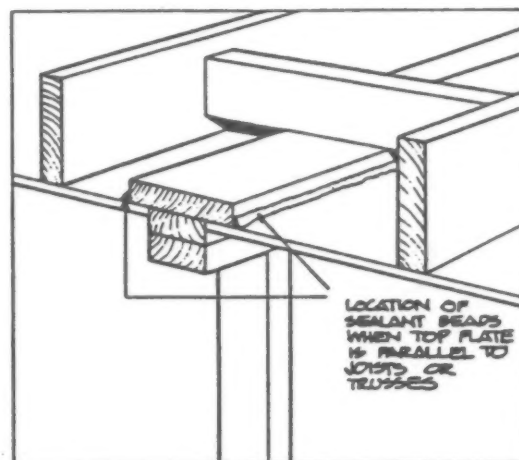


* Figure 4.11

The recommended application technique is described in Exhibit 10 and is illustrated below in Figures 4.12 and 4.13.



* Figure 4.12



* Figure 4.13

* Source: Ibid. pg. 11.9

EXHIBIT 10

SEALING THE TOPS OF PARTITION WALLS

This Exhibit provides a technique for sealing joints at the top of interior partition walls.

PREPARATION

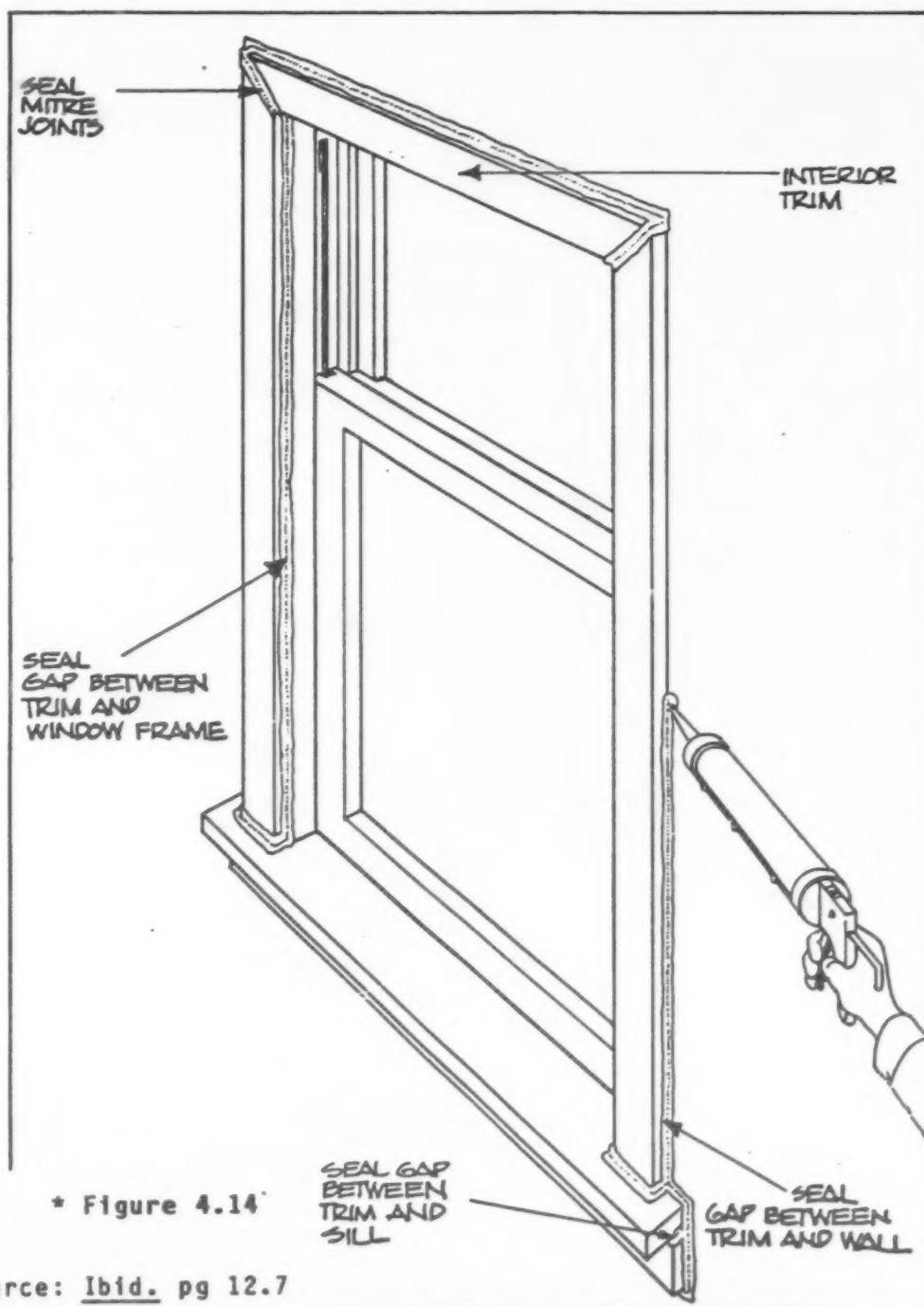
1. Identify the location of the partition walls.
2. Remove or brush aside the attic insulation from above the walls.
3. Use a small brush or whisk broom to clear all cracks of insulation and debris.
4. Clean surfaces to be sealed by wiping with MEK.

APPLICATION

1. Apply a uniform and continuous bead of silicone or acoustical sealant along the entire length of the partition wall on either side of the top plate, as shown in Figures 4.13 and 4.14.
2. Where two partition walls meet with one running parallel to the trusses/joists and the other running perpendicular, combinations of the above techniques should be used, as required, to seal at the joint.
3. Replace the original insulation.

Source: Ibid. pg. 11.10

- 4.3.8 Sealing Around Interior Window Trim:** Figure 4.14 and Exhibit 11 illustrate an application procedure in which the window trim is not removed. Alternately, if appearance is a concern, the trim can be removed and the space sealed in the same manner as described in Section 4.3.3 for door sealing.



* Source: Ibid. pg 12.7

EXHIBIT 11

SEALING INTERIOR TRIM WITHOUT REMOVAL

This Exhibit covers the sealing of air leakage points around interior window trim, without removing the trim.

PREPARATION

1. Inspect the trim. If the gap between the trim and the wall exceeds 3mm, use nails to attach the trim more closely to the wall.
2. Clean the outside edge of the trim and surrounding wall surface with soap and water to remove dirt and grease. Wipe with MEK.

APPLICATION

(See Figure 4.14)

1. Run a continuous bead of sealant around the gap between the window trim and the wall. Adjust the width of the bead according to the size of the gap. Good caulking technique is required to maintain a tidy bead.
2. Run a needle bead into the trim mitre joints, where required. Similarly, run a needle bead into any gap between the trim and the window frame. Remove excess sealant and wipe clean.

Source: Ibid. pg. 12.7

4.4 Estimated Costs and Fuel Savings

The cost of the above measures is estimated to be approximately:

Sealing and Weatherstripping material	\$ 100
Additional Insulation	150
New Wood Stove*	600*(if required)
New Chimney and Smoke Pipe	<u>400*(if required)</u>
Total:	\$1250

*Note: In several of the homes inspected, Class-A prefabricated chimneys and Fisher airtight wood stoves were already installed. Therefore, retrofit costs for these homes would be reduced to about \$250 plus transportation.

Implementation of the above measures is expected to reduce wood consumption by approximately 50%. Of equal or greater importance, the above measures would reduce uncomfortable drafts and would help to extend the life of the building by reducing possible moisture damage.

4.5 Impacts

The major impacts resulting from widespread implementation of the above retrofit measures are outlined below.

4.5.1 **Environmental Impacts:** As the energy efficiency of the existing housing units is gradually upgraded, the community's total demand for wood for space heating will similarly gradually decline. A 5 to 10 year housing plan which seeks to combine energy efficient new housing (Section 3) with upgraded existing housing could reduce

overall community wood demand by 50% or more . This will reduce the distances required to go for wood supplies and/or will make other substitution options (ie. wood fuel in schools) attractive without placing additional strains on the existing resource base.

4.5.2 Economic Impacts: The major economic impacts of the above measures are: short term employment; extended life of existing housing; and reduced individual costs for collecting wood.

4.5.3 Social Impacts: The principal social impacts would be more comfortable housing and less time required for wood collection. However, it must also be cautioned that the safe operation of efficient airtight wood stoves requires the use of dry (as opposed to green) wood and the regular inspection and cleaning of chimneys.

4.6 Implementation Plan

4.6.1 Overview: This option can be implemented initially either in conjunction with the new housing option (Section 3) or as an additional component of the Band's existing and on-going housing renovation program. If initially implemented in conjunction with the new housing option, the firm's on-site foreman could assist the local carpenters by demonstrating the proper procedures. Alternatively, this option can be implemented independently within the existing Band housing renovation program. As the procedures outlined are relatively simple, the technical section of this report can be used as a guide to proper application. As part of the existing renovation program, energy retrofit measures would be identified and carried out at the same time as other renovation work is performed on an individual house.

4.6.2 Sequence of Events: If implemented as part of the ongoing housing renovation program, the steps involved for retrofitting follow exactly those of other renovation measures. That is:

- identification of houses and renovation/retrofit measures
- allocation/application for funding
- procurement of materials
- installation, with assistance of the technical procedures outlined in this report.

Alternately, if initially implemented in conjunction with the new housing option, the above steps would be carried out with the assistance of the site foreman for the first 3 or 4 houses. Thereafter, energy retrofit measures would be implemented as part of the renovation program.

4.6.3 Project Management: No significant changes to the existing administrative/management procedures for housing renovations are required.

4.6.4 Skills/Technology Transfer Required: The application of the air sealing techniques described above are not particularly complex. In most cases, a review of the technical material presented in this section of the report will enable the housing coordinator and/or an experienced local carpenter to instruct local crews.

Alternately, if implemented in conjunction with the new housing option (Section 3) the on-site foreman could provide the necessary on-site training.

4.6.5 Funding: The existing CMHC and DIAND funds for renovation work (\$6,250 per house from CMHC and \$6000 from DIAND) are sufficient. There is no reason why energy efficiency retrofit measures can not be included within existing funding programs.

SECTION 5

UPGRADING EXISTING BAND BUILDINGS

5.1 Description of Current Situation

The major existing non-residential band owned buildings which have significant space heating demands are:

- Band Office - all communities
- Co-op Store - Bearskin, Sachigo
- Coffee Shop - Bearskin, Sachigo, Weagamow

Other existing band buildings include small craft shops, garages, and community centres. However, this latter group of buildings are generally not heated on a regular basis and when heated, locally purchased wood fuel is used. Consequently, there was little local interest or economic incentive to pursue energy retrofits on these buildings.

With respect to the first group of buildings, it was the band offices in Bearskin Lake and Weagamow where the greatest interest and opportunity for retrofit measures were noted. The band offices in Bearskin Lake and Weagamow Lake are examples of two different building types with two different types of heating problems.

- 5.1.1 **Bearskin Lake Band Office:** At Bearskin Lake, the band office is a standard single storey wood frame building with an oil fired hot air heating system. A new wood fired hot air furnace has been installed beside the oil fired furnace but it has not been correctly connected to the oil unit. Not only is the wood furnace unused but the method of connection diverts hot air from the oil furnace into the attic. There is also insufficient room for wood

storage or ash clean out in the furnace room. Because the building has no heated crawl space, all heating ducts run through the attic space with warm vents in the ceiling of some rooms and the walls of others. This results in very poor air distribution within the building. Some rooms are too hot, others are too cold and floors are generally cold. The ceiling and insulation above the furnace room has also been removed which aggravates the air distribution problem and wastes a great deal of heat and oil.

- 5.1.2 **Weagamow Lake Band Office:** At Weagamow Lake, the band office is a recently built two-storey log building which also houses the community post office. The building is about 20m long and 7m wide. It is heated with two barrel stoves, centrally placed on each floor. These stoves burn down very quickly at night, resulting in the building being very cold each morning. The stoves also do not adequately heat all corners of the building when they are being used.

5.2 Description of Option

Specific retrofit options are recommended for the band offices at both Bearskin Lake and Weagamow Lake.

- 5.2.1 **Bearskin Lake Band Office:** As a minimum, to reduce oil consumption and allow the wood furnace to be used, the ductwork in the furnace room needs to be modified, the ceiling closed in and insulated, and insulation placed over the distribution ducts in the attic space. Each of these measures is outlined below.

- Furnace Modifications: The wood and oil furnaces are currently connected in parallel but only the oil furnace has an air circulation fan. The result is that the oil furnace fan blows warm air backwards

through the wood furnace into the furnace room as well as into the distribution system. Because the wood furnace presents less flow resistance, more hot air is blown into the furnace room (and up into the attic space through the open ceiling) than reaches the offices. Because the wood furnace does not have its own fan, the same thing would happen when wood was being burned (in fact, no wood heated air would ever reach the offices). The two furnaces should be reconnected in series so that the oil furnace fan draws air through the wood furnace before blowing it through the oil furnace. The existing cold air return should be connected to the wood furnace cold air return flange. The wood furnace's warm air outlet should be connected to the oil furnace's cold air return instead of the building's main warm air distribution duct. The fan control and wood burning draft damper control units need to be re-wired, accordingly. The reducing and control changes should be carried out by a qualified furnace installer.

- Closing in Furnace Room: A new ceiling should be built in the furnace room with a drywall finish and attic hatch. Insulation should be placed over the new ceiling and over the air distribution ducts running through the attic space.
- Improving Heat Distribution: To provide more heat to the large rear office a new duct should be installed along the upper wall of the office connected to the existing short duct through the wall from the furnace room. Two or three vents should be placed in this duct for distribution. This will provide improved comfort in the rear office and reduce the temperature difference between one office and another.

5.2.2 Weagamow Band Office: It is recommended that the two barrel stoves be replaced by large capacity radiant heat airtight wood stoves (eg, Fisher) or large capacity steel box stoves with semi-automatic thermostat (eg, Valley Comfort). These brand names are mentioned as they are already used in many of the other Windigo communities. Appendix B provides a partial list of other wood stoves which have been performance tested and would also be suitable. These stoves would provide more heat and could be kept burning overnight. They would also provide more horizontal radiant heat, although this may not be required in the small hall areas where they would be located. The best method to use for moving warm air to all parts of the building would be to mount small fans over the 4 doorways leading out of the hallways where the stoves are located.

5.3 Estimated Cost and Fuel Savings

5.3.1 Bearskin Lake Band Office: The estimated costs for each of the measures outlined above in Section 5.2.1 are presented below:

<u>Measure</u>	<u>Material</u>	<u>Labour</u>	<u>Total</u>
• Furnace Modification	\$ 200	\$ 750	\$ 950
• Closing in Furnace Room and Insulating Ducts	\$ 250	\$ 300	\$ 550
• Improving Heat Distribution	<u>\$ 100</u>	<u>\$ 100</u>	<u>\$ 200</u>
Totals	\$ 550	\$1150	<u>\$1700</u>

It is estimated that implementation of these measures will reduce current fuel oil consumption by 40-50%. At present

fuel oil prices, this is estimated to result in annual savings of about \$2,000. The payback period is therefore less than 1 year. Further cost savings would be achieved by using the wood furnace during office hours and purchasing local wood fuel supplies instead of fuel oil.

5.3.2 Weagamow Lake Band Office: The estimated cost for improving the Band office's heating system is presented below:

• 2 efficient large capacity wood stoves @ \$900	\$1800
• 2 prefabricated chimney units	1000
• 4 circulating fans @ \$30	<u>120</u>
Total	\$2920

It is estimated that the replacement of the existing wood stoves with new energy efficient ones and the installation of circulating fans would reduce wood consumption by approximately 50%.

5.4 Impacts

In both applications the principal impact would be a significant reduction in fuel consumption and costs as well as increased comfort. In the case of Bearskin Lake, the fuel savings are particularly important as the office is currently heated by fuel oil.

5.5 Implementation Plan

5.5.1 Overview: Bearskin Lake: The replacement of the ceiling in the furnace room and the placing of insulation over the ducts running through the attic can easily be carried out by local carpenters. However, it is recommended that a

qualified furnace installer be retained for implementation of the remaining measures.

Weagamow Lake: Either the Fisher or Valley Comfort stoves mentioned above or a large capacity model of any of those listed in Appendix B will be adequate.

Most of these models are available through suppliers in Thunder Bay and Winnipeg. It is important that a prefabricated insulated chimney be used with these stoves in order to ensure proper performance and fire safety. As with any efficient wood stove, increased attention needs to be given to the use of dry wood and to regular chimney inspections and cleanings. Both of these operating procedures are necessary to ensure that creosote deposits do not build up and create a fire hazard.

- 5.5.2 Sequence of Events:** The implementation of the above measures are straightforward and, consequently, require no further elaboration.

SECTION 6

UPGRADING SCHOOL BUILDINGS

6.1 Description of Current Situation

The school buildings in the Windigo communities were built between 1967 and 1983. Details of the buildings and their heating systems are as follows:

Community	Year Built	Construction	Heating System
Sachigo	1967	Wood frame	Oil boiler
Bearskin	1968	Wood frame	Oil boiler
Weagamow 1	1967	Wood frame	Oil boiler
Weagamow 2	1974	Wood frame	Oil furnace
Cat Lake	1975	Wood frame	Oil furnace
Muskrat Dam	1983	Wood frame	Wood/oil furnace
Slate Falls	1983	Log	Wood stove

From consultation with school principals in the communities where oil is used for heating, the average fuel consumption during the heating season is about 3000 litres/month (750 gallons/month). This would amount to about 20,000 litres/year or up to \$13,000 per year per school. While the schools are in fairly sound structural condition, several of them are becoming overcrowded. In Weagamow a new school was built around 1974. In Bearskin an annex was built onto the main building in 1982. In Sachigo some classes are held in a building originally built as a teacherage.

Schools at Bearskin Lake and Weagamow are similar in age and construction to the school at Sachigo but are slightly

larger. All would have a similar pattern of heat losses and promise similar potential savings from energy retrofit measures.

The school at Cat Lake is of more recent construction (1975) and probably has higher insulation levels. The schools in Muskrat Dam and Slate Falls were built in 1983. The school at Muskrat Dam is a 2 classroom, wood frame building with a combination wood/oil furnace heating system. The school at Slate Falls is a log building and is heated by a single, efficient wood stove.

6.2 Description of Option

It may be assumed that the current buildings will continue to be used for several years either as schools, or as community buildings, if a new school is built. It is therefore worthwhile to upgrade the air tightness and insulation in the schools to reduce fuel costs and to generally increase comfort.

In order to determine where the highest savings can be obtained for the least cost, it is necessary to carry out an energy audit. The Sachigo Lake school was selected, as this community's facilities are the primary focus of the study. Appendix C shows the results of the energy audit on the Sachigo school based on a site visit made on January 15, 1984. The energy audit shows that the largest heat losses are through infiltration and convection through the ceiling and floor. The energy audit further shows that the design heat loss for the building (the heat loss rate for which the heating system should be sized) is about 70,000 Watts (240,000 Btu/hr). The current boiler at Sachigo school is rated at 668,000 Btu/hr, meaning that on the coldest days, the boiler is operating about one-third of the time or at one-third capacity. The audit also

shows that the expected annual fuel consumption would be about 20,000 litres (4500 gallons). This agrees well with the principal's estimate of 3000 litres/month (750 gallons/month) during the heating season.

Based on both the audit results and the site inspection, the following measures are recommended for the Sachigo Lake school:

- upgrade attic insulation
- improve air sealing

These measures will also be generally applicable to the other schools of the Windigo area, particularly those noted as having a similar construction type.

6.2.1 Attic Insulation: As shown in the energy audit (Appendix C), heat losses through the ceiling/attic represent the second largest area of heat loss (13,000 watts). It is therefore recommended that insulation levels be upgraded from the present RSI 2.3 (R-12) to RSI 7 (R-40). This would reduce losses to 4300 watts. RSI 4.9 (R-28) batts can be laid over the existing batts.

6.2.2 Air Sealing: Air infiltration losses represent the largest source of heat loss (32,000 watts or 46%) and therefore merit significant attention. Air sealing is desirable not only to cut heat losses but also to prevent possible moisture damage. Attic air sealing measures are particularly important if the attic insulation is increased. The recommended air sealing measures are:

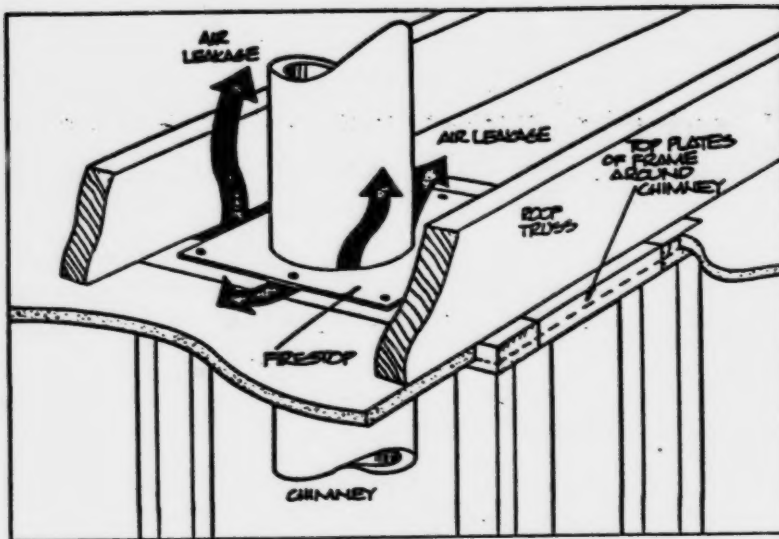
- Seal gaps between exterior doors and door frame
- Seal gaps between the exterior door frames and the surrounding wall

- . Seal electrical receptacles in exterior walls
- . Seal electrical receptacles in attic space
- . Seal attic hatch
- . Seal gaps between top plates of partition walls and ceilings
- . Seal around the furnace chimney
- . Seal around plumbing stacks
- . Seal the junction between the foundation and the main floor (in the crawl space)

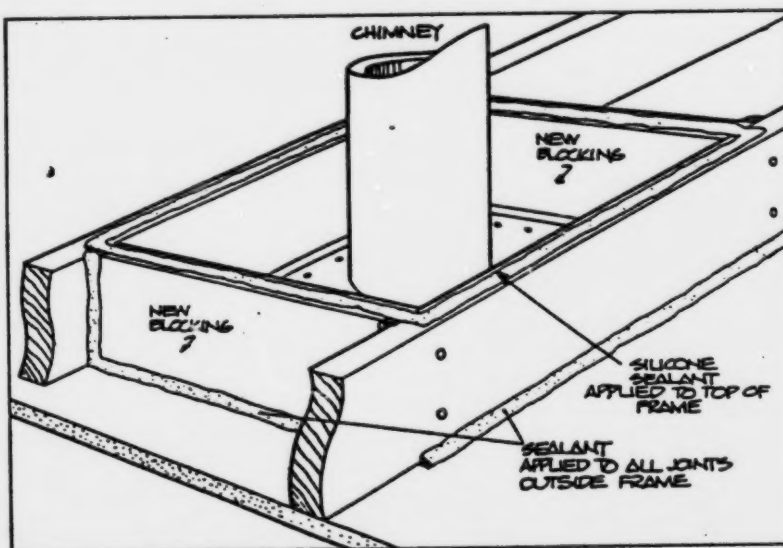
6.3 Technical Details

The principles of air sealing have been presented previously in Section 4.3 and are therefore not repeated here. Similarly procedures for implementing all but the last three air sealing measures have been presented previously in Section 4.3.2 through 4.3.8 and are not repeated here. Detailed application techniques are presented for the remaining measures.

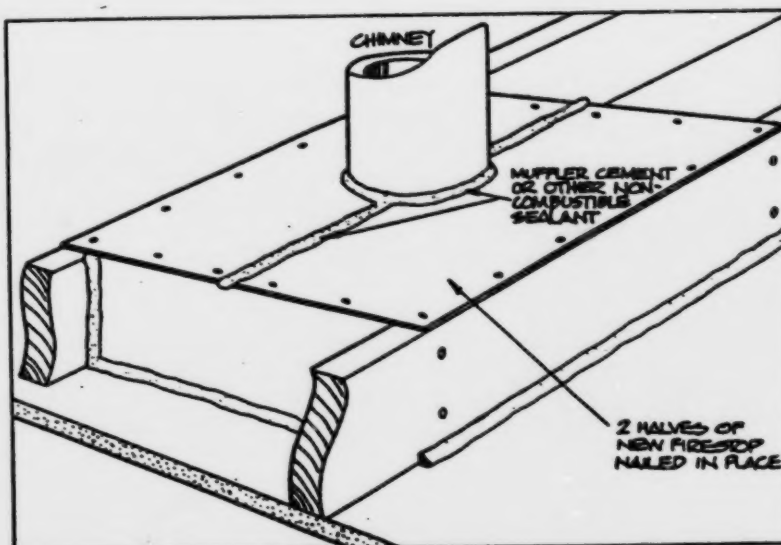
- 6.3.1 **Sealing Around the Furnace Chimney:** The furnace chimney in the Sachigo Lake school (and in the other schools inspected) is a factory-built metal chimney. Exhibit 12 presents an excerpt from the previously cited publication, Air Sealing Homes for Energy Conservation which describes the recommended application procedures as well as presenting an important cautionary note. Figure 6.1 shows a typical installation; Figures 6.2, 6.3 and 6.4 illustrate the proper application of this technique.



* Figure 6.1



* Figure 6.2



* Figure 6.3

* Source: Ibid.
pg. 11.19

EXHIBIT 12**SEALING AROUND FACTORY-BUILT METAL CHIMNEYS**

This Exhibit outlines a technique for sealing around factory-built metal chimneys. However, before sealing such chimneys, contractors should be aware of two limitations:

- First, the technique described may contravene the certification requirements of some chimneys. Specifically, boxing-in a chimney section with firestops and applying sealant between a chimney and the surrounding firestop could affect the safe performance of certain chimneys. Therefore, before proceeding, always ensure that local codes, building material standards, and the manufacturer's instructions permit the sealing procedure described.
- Second, the National Building Code (NBC) sets as a guideline a minimum 50mm space between the outside surface of any chimney and the nearest combustible surface. Contractors finding construction that does not meet these guidelines should not proceed with any sealing around the chimney, until the problem has been corrected.

Figure 6.1 illustrates a typical installation of a factory-built metal chimney. Note that, though these chimneys are insulated, they can nevertheless get hot. Accordingly, they should have been installed with a firestop surrounding the chimney where it passes through the ceiling into the attic (though some chimneys have been improperly installed without firestops).

Firestops are normally metal sheets. They are usually poorly fitted, and so allow a large amount of air leakage, as shown in Figure 6.1. In addition, within a certain radius of the chimney, they cannot (by code) have any insulation directly on top - which results in considerable heat loss.

This Exhibit outlines a technique for installing a new, properly sealed firestop. The steps apply to the common case where the original, poorly fitted firestop is installed on the top plates of a frame around the

EXHIBIT 12

SEALING AROUND FACTORY-BUILT METAL CHIMNEYS

chimney. (If the existing firestop fits well and is in good condition, it can sometimes be sealed using an adaptation of these techniques.)

In addition, this Exhibit outlines steps for providing insulation in the vicinity of the firestop, while maintaining a recommended 50mm clearance between the insulation and the chimney.

PREPARATION

1. Clear a working area by removing insulation and brushing away debris.
2. Install blocking between the roof trusses to make a tightly-fitted frame around the chimney.
3. Clear the various joints around the outside of the frame with a brush, MEK, and rags.

APPLICATION

1. Apply water-based acrylic or silicone sealant at all joints on the outside of the frame, as shown in Figure 6.2.
2. Prepare a thin galvanized metal sheet to fit around the chimney. The sheet should be in two sections, sized to match the top of the wood frame.
3. Apply a silicone sealant bead around the top of the frame, as shown.
4. Install the new metal sheet to be a tight fit around the chimney, and nail in place on top of the sealant bead.
5. Apply muffler cement or other non-combustible sealant to the joint between the two sections of firestop and between the firestop and the chimney, as shown in Figure 6.3. Use a fine wire mesh as a backing for the sealant, if required.
6. Obtain a custom-made cylinder of thin, rolled galvanized metal, with unjoined edges.

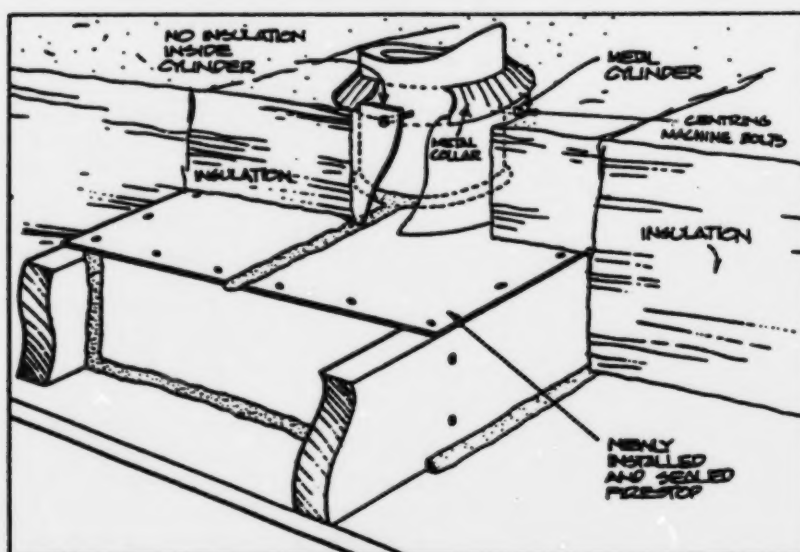
EXHIBIT 12 SEALING AROUND FACTORY-BUILT METAL CHIMNEYS

This cylinder should have a diameter at least 100mm larger than that of the chimney, and should be at least 300mm high. Install the cylinder around the chimney, on top of the new firestop. Join the edges with self-tapping metal screws.

7. Install three or four long machine bolts through the cylinder, and adjust to centre the cylinder. The gap between the cylinder and the chimney should be 50-75mm all around, or as required by the type of chimney and type of insulation being used. The bolts must not pierce the walls of the chimney, as this will usually void the chimney certification.

8. Obtain or make a metal collar, designed to fit around the chimney. The collar should be positioned on top of the metal cylinder, covering the gap between the chimney and cylinder (so as to prevent insulation or debris from falling into the gap).

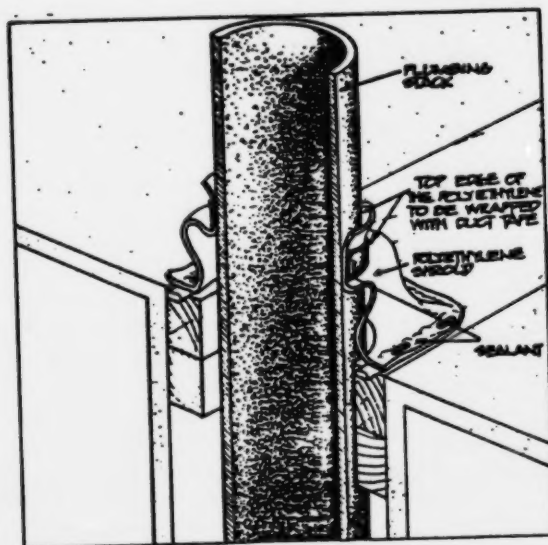
9. Replace the insulation, as shown in Figure 6.4. There can be no insulation between the chimney and the new cylinder.



* Figure 6.4

* Source: Ibid. pg. 11.19

6.3.2 **Sealing Around Plumbing Stacks:** Exhibit 13 presents two techniques for sealing around plumbing stacks. Figure 6.5 illustrates the polyethylene technique.



★ Figure 6.5

★ Source: Ibid. pg. 11.16

EXHIBIT 13

SEALING AROUND PLUMBING STACKS

This Exhibit outlines techniques for sealing around plumbing stacks. Two techniques are presented, the choice being determined principally by the size of the gap around the stack. Both options are designed to give a reasonably tight seal, while allowing the stack to move upwards and downwards under the effects of thermal expansion.

PREPARATION

1. If there is no adequate seal around any or all of the stacks, remove insulation and debris from around the stack.
2. If the polyethylene technique is to be used, clean the working surface around the stack with a wire brush, MEK, and rags. Similarly, clean a band around the plumbing stack itself, where the polyethylene is to be applied.

APPLICATION Oakum Technique

1. Inspect the gap around the stack. This technique may be used only in those cases where the stack passes through the top plates of a plumbing wall, and then only if there is a fairly regular gap of less than 18mm around the stack.
2. Work oakum into the gap and compress it as tightly as possible using a blunt tool.
3. Replace the original insulation.

APPLICATION Polyethylene technique (See Figure 6.5)

1. Inspect the gap around the stack. This technique should be used where the oakum technique is unsuitable because:
 - the gap around the stack exceeds 18mm; or
 - the gap is irregular; or
 - the gap is too small to allow insertion of oakum; or
 - the stack comes directly through the ceiling finish and there is no surrounding wood frame in which to compress oakum.

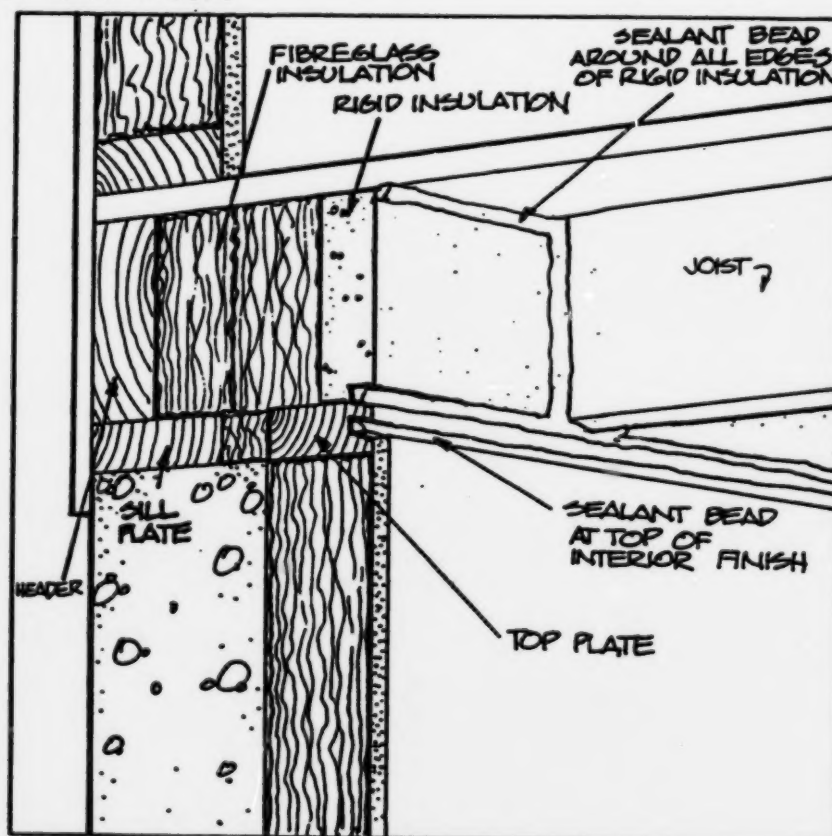
EXHIBIT 13 SEALING AROUND PLUMBING STACKS

2. Cut a strip of 0.150mm polyethylene 300mm wide and long enough to wrap around the stack with a good overlap.
3. Apply a bead of acoustical sealant around the stack, where the polyethylene is to be sealed. Position the bead so that, when the installation is complete, the polyethylene shroud will have considerable loose material. This is necessary to allow for vertical movement of the stack due to expansion and contraction. As much as 25mm of movement must be allowed for.
4. Wrap the polyethylene around the stack and pull tight to make good contact with the sealant.
5. Wrap several turns of duct tape around the stack so that it covers the bead of sealant, the top edge of the polyethylene, and the adjacent stack surface.
6. Apply acoustical sealant between the two layers of polyethylene at the vertical overlapping seam. Secure this joint with a standard paper stapler.
7. Apply a bead of acoustical sealant on the top plate or ceiling surface around the stack.
8. Press the bottom of the polyethylene shroud into the sealant to make a good seal all around. Secure the seal by stapling through the polyethylene and bead into the top plate or ceiling.
9. Replace the original insulation.

Source: Ibid. pg. 11.16

- 6.3.3 Sealing the Junction Between the Foundation and the Main Floor:** In the Sachigo School, rigid insulation has been installed on the inside of the foundation wall and against the header between the floor joists. This insulation is reducing some heat losses but has not been properly air sealed. The site inspection confirmed that this area remains a major source of air infiltration and heat loss despite the existence of insulation.

Figure 6.6 illustrates the recommended technique for insulating and sealing the junction between the foundation and the main floor.



* Figure 6.6

Exhibit 14 is an excerpt from the previously cited publication and presents the recommended application procedures for sealing and insulating the function between the foundation and the main floor.

EXHIBIT 14
SEALING AND INSULATING THE JUNCTION BETWEEN
THE FOUNDATION AND THE MAIN FLOOR

This Exhibit outlines the rigid insulation technique for sealing the junction between the foundation and the wall above. When rigid insulation materials are used, some form of fire protection (such as drywall) must be provided.

PREPARATION

1. Using a whisk broom and scraper, clean all surfaces to which any sealant must adhere.
2. Wipe the surfaces with a clean white rag soaked in MEK.

APPLICATION Rigid insulation technique
(See Figure 6.6)

1. Seal the joints in the subfloor above each cavity that is to be insulated and sealed. Unless the gaps are large, water-based acrylic sealant can be used.
2. Apply a bead of sealant at the joint between the interior finish and the top plate, if this area is not already well sealed. (In the case of an unfinished basement, apply a bead of high solids butyl rubber or polysulphide sealant to the joint between the foundation wall and the sill plate.)
3. Fill the cavities above the foundation wall with fibreglass batt insulation.
4. Cut pieces of rigid board insulation to fit snugly into the spaces between the floor joists, subfloor, and top plate of the finished stud wall.
5. Push the rigid board insulation into place between the floor joists.
6. Apply a uniform and continuous bead of acoustical sealant at the joints between the rigid insulation board and the surrounding wood surfaces.

EXHIBIT 14
SEALING AND INSULATING THE JUNCTION BETWEEN
THE FOUNDATION AND THE MAIN FLOOR

7. Install suitable fire protection over the rigid insulation, as required by local fire codes. The ceiling over a finished basement, when re-installed, may be sufficient.

8. The above steps refer to the foundation wall running perpendicular to the joists. The walls running parallel to the joists may be more difficult to seal, particularly if access to the space above the foundation wall is restricted.

Source: Ibid. pg. 8.23

6.4 Estimated Costs and Fuel Savings

The rough cost estimate for these measures is:

Air Sealing Materials	\$350
Fiberglass Insulation [350m ² RSI 4.9 (R-28)]	1,200
Labour (75 man hours @ 15/hr)	1,125
Transportation	<u>1,000</u>
TOTAL:	\$3,675

It is estimated that implementation of the above measures would reduce fuel consumption by about 28%. At 65¢/litre, the resulting saving is about \$3,600 per year.

The simple payback is therefore 1 year.

6.5 Impacts

The principal impacts resulting from the implementation of these measures are reduced fuel consumption and costs and increased comfort.

6.6 Implementation

Implementation of the above measures is presently within the jurisdiction of DIAND. DIAND is currently undertaking steps to gradually retrofit its school facilities; the above outline of measures will be of benefit to them in selecting specific measures. Implementation would be via their normal contractual procedures. Therefore no further elaboration is provided.

SECTION 7

SUBSTITUTION OF WOOD FOR OIL
IN SCHOOL HEATING SYSTEMS

7.1 Description of Current Situation

The heating systems installed in Windigo community schools are as follows:

<u>Community</u>	<u>Heating System</u>	<u>Rating</u>
Sachigo Lake	Oil fired burners	668,000 Btu/hr
Bearskin Lake	Oil fired boilers	(1) 672,000 Btu/hr (2) 322,000 Btu/hr
Weagamow Lake #1	Oil fired boilers	(1) 230,000 Btu/hr (2) 230,000 Btu/hr
Weagamow Lake #2	Oil fired furnace	190,000 Btu/hr
Cat Lake	Oil fired furnaces	(1) 244,000 Btu/hr (2) 244,000 Btu/hr (3) 82,000 Btu/hr
Muskrat Dam	Wood/oil fired furnace	150,000 Btu/hr
Slate Falls	Wood stove	N/A

The older schools (Sachigo, Bearskin, and Weagamow #1) tend to have hot water heating systems, whereas the newer schools tend to have hot air heating systems. This is probably because hot air systems usually have a lower installed cost and not because they are more effective. In fact, boilers tend to have higher fuel efficiencies (75-80%) than furnaces (65-70%).

Wood heating systems have already been installed in the two newest schools. The new school at Muskrat Dam has a wood/oil furnace and the Slate Falls school has a single efficient wood stove. In all of the other communities there is strong interest in converting the existing oil heating systems to wood/oil combination units. This interest was expressed not only by the local Band representatives but also by the resident school principals and DIAND district office staff.

7.2 Description of Option

The conversion to wood heating or addition of a wood heating system would require some modifications to the existing boiler/furnace and, in some cases, to the boiler/furnace room. Storage space for wood and an entry chute would be required.

Conversations with the DIAND staff in Sioux Lookout indicate that the larger boilers in Sachigo Lake and Bearskin Lake are in need of replacement. In both cases, they could be replaced with new dual wood/oil fired boilers. In addition, the boiler rooms need to be extended to accommodate a wood chute and a small amount of inside wood storage. A larger area for outside wood storage is also required.

At Weagamow #1 it may be preferable to add a wood boiler rather than replace the present units with a dual fuel system. The present units are not due for replacement, and a small 200,000 Btu/hr wood boiler would be able to carry the heating load for most of the heating season. The oil fired units could be used for auxilliary heating in very cold weather and as a back-up. Alternatively both oil fired units could be replaced in a few years with a single wood/oil dual fuel boiler similar to those suggested for Sachigo and Bearskin.

At Weagamow #2, there is already some inside wood storage space and a wood entry chute into the furnace room. The recommendation here would be to install a 200,000 Btu/hr wood hot air furnace alongside the existing oil furnace which would become a back-up.

At Cat Lake the three existing oil furnaces are designed to heat three separate parts of the school. Installation of a large wood furnace capable of heating the whole school would require some changes in ducting as well as the construction of a wood storage area and wood chute. One slight advantage at the Cat Lake school is that the furnace room is at grade level. In other schools it is either at crawl space or basement level.

7.3 Technical Details

Wood/oil furnaces and dual fuel boilers are both fully proven technologies and are commercially available from most heating system suppliers. In fact, while in Bearskin Lake, the Study Team met with a heating system supplier/-installation firm which, under contract to DIAND, was carrying out modifications to the school heating system. A joint inspection of the school's heating system with the heating firm confirmed the technical feasibility of implementing the suggested conversion.

Dual fuel systems (wood/oil) are recommended over a straight wood system for the following reasons:

- . the system is not dependent on a single fuel source and can continue to operate in the event of a shortage of one fuel source.
- . dual fuel systems do not require continuous monitoring and feeding. If the wood supply burns down (ie during the night), the oil system will automatically switch on to meet any heat demand. It is estimated that 3 or 4 loadings of wood/day would be sufficient. Beyond this manual loading requirement, the system would continue to run automatically.
- . the oil system can be used to bring the system/school up to the desired temperature more quickly. The wood system can then be used to maintain the temperature.

The new dual fuel systems suggested here are far superior to the wood heating system in the old school at Big Trout Lake. In comparison, these new dual fuel heating systems are physically much smaller, are much more energy efficient and do not require the hiring of additional operators.

7.4 Estimated Cost and Fuel Savings

- 7.4.1 Dual Fuel Boilers:** Consultations with both DIAND personnel (who are already investigating this option) and a heating system supplier/installer indicate that the installed cost increment for a new dual fuel rather than an oil fired boiler in the 200,000 to 600,000 Btu/hr range is about \$5,000. The additional cost of replacing the existing Sachigo and Bearskin school boilers with a dual fuel system would therefore be limited to the

incremental boiler cost of \$5,000 plus an additional cost of about \$5,000 to modify the boiler room.

In Section 6.1, it was estimated that the annual heating load for a typical school such as Sachigo Lake is about 150,000 kWh/yr (540 GJ/year). If this were all supplied by the burning of air dried spruce logs (energy content 18 GJ/cord) in a boiler with a 65% combustion efficiency, the annual wood consumption would be 46 cords per year $[540/(18 \times 0.65)]$.

The estimated annual fuel oil consumption at Sachigo is 20,000 litres/year; at 65¢/litre this is worth \$13,000 per year. It is reasonable to assume that wood would be able to be substituted for oil about 75% of the time during the heating season. This means that fuel oil consumption would be reduced by about 15,000 l/annum. At 65¢/litre this saving is worth about \$9,750/annum. In order to displace this amount of fuel oil, 35 cords of wood are required. At \$150/cord, this represents a cost of \$5,250. Therefore the annual saving, at present fuel costs is:

. Cost of 15,000 litres of oil:	\$9,750
. Cost of 35 cords of wood:	<u>\$5,250</u>
. Annual fuel savings:	\$4,500

A simple economic analysis for the replacement of the present oil boiler at Sachigo with a dual fuel wood/oil boiler rather than a conventional oil boiler is presented below:

Additional cost of new dual fuel boiler:	\$5,000
Extensions to boiler room	<u>\$5,000</u>
Incremental cost:	\$10,000

Annual savings through the use of
 35 cords of wood at \$150/cord instead
 of 15,000 litres of fuel oil
 @ 65¢ ls: \$4,500

Simple payback time: $\frac{\text{Incremental Cost}}{\text{Annual Savings}} = 2.2 \text{ years}$

- 7.4.2 **Wood Furnace:** The estimated cost of a wood fired hot air furnace in the 200,000 BTU/hr range is \$5,000. A simple economic analysis for the addition of a wood furnace at Weagamow #2 is as follows:

Cost of new wood furnace and
 its installations: \$5,000

Annual savings assuming the same
 as for Sachigo: \$4,500

Simple payback time: $\frac{\text{Cost}}{\text{Annual Savings}} = 1.1 \text{ years}$

7.5 Impacts

The principal impacts resulting from the implementation of this option are economic and environmental. Each is discussed below.

- 7.5.1 **Economic Impact:** In the short term, the conversion of oil fired school heating systems to dual fuel system presents economic advantages for both DIAND (the current operator) and the community. For the community, this option would result in the creation of 1 or 2 permanent part-time jobs associated with the annual harvesting and transportation

of about 35 cords of fuel wood. For DIAND, this option offers the potential to reduce annual heating costs by about \$4,500 (at 65¢/litre). This option also presents further, less direct economic benefits, namely:

- . at present, DIAND purchases and transports most of its fuel supplies in bulk, on an annual basis. The result is lower unit fuel costs. However, periodically, this annual bulk delivery is insufficient to meet the total annual demand. In these circumstances (particularly in non-airport communities where ice conditions permit bulk transportation only in January or February) additional fuel supplies must be transported using small charter aircraft. The result is very high unit fuel costs. The existence of an alternative fuel source (wood) would provide an alternative to incurring these additional and high fuel oil costs; and,
- . in the event of a heating system failure, the existence of an alternative heating system would ensure that the school facilities do not freeze up before repair crews arrive and correct the problem.

In the longer term, it is assumed that these facilities will become Band owned under the move to self-government. At that point, all of the above economic benefits will accrue directly to the Band. This assumes that some form of block funding will be associated with self-government.

- 7.5.2 Environmental Impacts:** Implementation of this option would involve the harvesting of an additional 35 cords of wood. This would add approximately 5% to the current annual wood harvest and therefore does not represent a major increase. In fact, if the measures related to more efficient housing (Sections 3 and 4) are implemented, the

increased wood harvest resulting from this option would be more than offset.

7.6 Implementation Plan

7.6.1 Overview: A Band Council Resolution (BCR) requesting DIAND to incorporate a dual fuel heating system into its school renovation plans would be prepared and presented to DIAND. Assuming a favourable response by DIAND, conversion of the heating system could be expected within 1 to 2 years based on DIAND's estimated renovation schedule. A contract between the Band and DIAND would be established which would specify volume, payments, delivery dates, etc. Thereafter the Band would assume responsibility for providing the wood as per the contract terms and would be paid accordingly. It is assumed that the Band would in turn hire 1 or 2 residents to actually provide the wood.

7.6.2 Sequence of Events: From the Band's perspective, the following steps are required:

- Present BCR requesting that renovations to the school's heating system include conversion to a dual fuel system
- Establish contractual terms with DIAND eg, volume of wood, cost per cord, delivery date, etc.
- Select and hire local residents who will harvest the wood
- Determine areas to be cut and ensure it does not create conflicts with other resident wood harvesting
- Harvest and stack wood in an outside storage area

- 7.6.3 Project Management:** The Sachigo Band has established arrangements for the harvesting and delivery of wood to the Band Office, the Co-op Store and the Coffee Shop. The volume of wood required to heat the school would be approximately equal to the amount currently purchased. Therefore, the present arrangement in which the Band identifies and contracts with local residents could simply be expanded to accommodate the increased requirement. Other Bands could establish similar arrangements.
- 7.6.3 Skills/Technology Transfer Required:** Local residents are very experienced in cutting and transporting fuel wood. No additional skills training is necessary given the relatively small volumes of wood involved. However, if at some future date, other fuel wood substitution options are identified (ie, wood-fired electricity generation) which require substantial increase in the volume of wood harvesting, then the Band should contract with a forestry consulting firm to develop a comprehensive wood lot management plan for the community. This would ensure that forest resources are not depleted.
- 7.6.5 Funding:** Under the present arrangements, the cost of heating system conversions is the responsibility of DIAND. Funds would need to be identified within DIAND capital and/or operating budgets. No Band expenditures are required.

SECTION 8

HEAT RECOVERY FROM COMMUNITY POWER SYSTEMS

8.1 Description of Current Situation

Weagamow Lake is the only Windigo community currently served by a community power system. In Sachigo Lake and Bearskin Lake, however, community power will be supplied in 1984. Two of the communities visited - Cat Lake and Muskrat Dam - do not yet have community power but expect to receive service within the next 5 years. No community power is currently scheduled for Slate Falls.

The Ontario Hydro system installed at Weagamow consists of three 100 KW diesel alternator sets manufactured by Mechtron Engineering Ltd. of Ottawa. Allis Chambers liquid cooled engines and Brown Boveri Canada Ltd. alternators are used. The system is designed such that only two engines can operate at any one time; the third engine acts as a stand-by unit. Therefore, the maximum output is 200 KW. The systems currently being installed at Sachigo Lake and Bearskin Lake employ liquid cooled engines, manufactured by John Deere Ltd. and will be rated as follows:

Sachigo Lake: 2 x 125 KW
 1 x 85 KW

Bearskin Lake: 1 x 175 KW
 1 x 125 KW
 1 x 85 KW

The new sets are more sophisticated than the Weagamow installation. To achieve greater fuel efficiency, they will be controlled such that as the load varies, engines

are automatically switched on or off to match the output with the load. Having different sized engines means that up to 7 different outputs can be obtained with the engines running at close to their design loading. (If diesel engines are run at less than 60% of their design loading, fuel consumption per unit power output declines and engine wear is increased.) The maximum output therefore at Sachigo Lake is theoretically 385 KW and at Bearskin Lake 335 KW.

8.2 Description of Option

There are specific opportunities in Bearskin Lake and Weagamow Lake for the use of heat recovered from community power generators. In Bearskin Lake, there are plans to build a community economic development centre close to the new community power generator building. There will be a year-round demand for hot water in the centre for a laundromat and fitness centre which could be supplied in part by heat recovered from the community power generators. In Weagamow Lake, there are plans to build a garage/warehouse building near the airport. There will be a seasonal space heating demand in both buildings which could be met by heat recovered from the community power generators.

Community power in Cat Lake and Muskrat Dam has not yet reached the design stage. This means that the location of the diesel sets has not yet been fixed. Both communities are also in the midst of community planning projects in which separate areas of the community are being designated respectively, as residential and institutional/commercial zones.

Diesel waste heat recovery for space and water heating can result in significant fuel savings. However, the location of the heat load (ie, a building) is very critical to the

feasibility of using the waste heat and realizing the potential savings. Ideally, the diesel sets and the buildings where waste heat is to be used should be located adjacent to each other. As a maximum, they should be no more than 100 meters apart. Further, institutional/-commercial buildings generally provide the best loads for waste heat because they are relatively large users of fuel for space and water heating. Therefore it is recommended that both Cat Lake and Muskrat Dam plan for the possible future use of waste heat within their present community planning projects. This would mean considering the practicalities of locating the future Ontario Hydro generators within the area allocated to institutional/-commercial buildings. If the diesel sets and institutional/-commercial buildings are located adjacent to each other, then the feasibility of waste heat recovery is much greater. If the new diesel sets are located at the airport, as is the general practice, then the opportunities for heat recovery will be significantly reduced.

Common local concerns regarding diesel noise and exhaust emissions can be relatively easily overcome by better insulation of the container building and improved exhaust systems.

8.3 Technical Details

Even when running at 60-100% of their design loading, diesel generator sets have a fuel to electrical efficiency of only about 35%. The remaining fuel energy is lost through engine cooling, exhaust gases, and engine radiation. Some energy is also lost in the alternator due to heat losses, etc. For example, the energy consumption of a 125 KW generating set running at full load breaks down approximately as follows:

Electrical output	125 KW (35%)
Generator losses	11 KW (3%)
Radiation losses	43 KW (12%)
Engine coolant	75 KW (21%)
Exhaust gases	<u>103 KW (29%)</u>
TOTAL	357 KW

Fuel consumption at this output would be about 35 litres/hour.

In a water cooled engine it is possible to recover heat from both the engine coolant and the exhaust gases. In an air cooled engine it is only practical to recover heat from the exhaust gases.

- Exhaust Heat Recovery : A special heat recovery silencer is attached to the exhaust system and a diverter valve is installed to allow the exhaust to be directed either through the heat recovery silencer or bypassed directly to the conventional silencer. A glycol/water solution is pumped through the heat recovery silencer and the hot solution may be used for space or water heating. (See Appendix D.)
- Coolant Heat Recovery: In liquid cooled engines, a glycol/water coolant is pumped between the engine and a radiator. The heat normally dissipated into the air by the radiator may be recovered by connecting a jacket coolant heat recovery heat exchanger upstream of the engine radiator, or by utilizing the hot air produced by the radiator. If a jacket coolant heat exchanger is used, the heat is recovered by pumping a glycol/water solution through the heat exchanger and using this solution for space or water heating. If the radiator is used, ducting is built around the

radiator and the hot air is then used directly for space heating. If the hot air method is used, the recovered heat can be practically used only in the generator building or in an attached building.

The equipment required to recover exhaust gas heat is always more expensive than the heat exchanger or ducting required to recover heat from the coolant in a liquid cooled engine. The effectiveness of exhaust heat recovery equipment is also lower than engine coolant heat recovery equipment. This is because exhaust gases cannot be cooled below about 175°C without acid condensation and corrosion occurring in the exhaust system. The effectiveness of an exhaust heat recovery silencer is seldom better than 60%, whereas a jacket coolant heat exchanger can have an effectiveness close to 100%. The maximum amount of heat that might be recovered from a 125 KW diesel generator running at full load would therefore be as follows:

Exhaust heat recoverable: 60 KW (0.22 GJ/hr)
(210,000 Btu/hr)

Jacket heat recoverable: 75 KW (0.27 GJ/hr)
(255,000 Btu/hr)

Total heat recoverable: 135 KW (0.49 GJ/hr)
(465,000 Btu/hr)

8.4 Estimated Cost and Fuel Savings

The facilities in which waste heat could be used in both Bearskin Lake and Weagamow Lake are at a preliminary stage of development. Final building design including construction type, size, siting, energy loads (space heating, hot water, etc.) have not been finalized. Each

of these factors will have significant bearing on the economic feasibility of waste heat recovery. Therefore, at this time, it is only possible to provide general cost estimates. However it is hoped that the estimates provided will show, in general terms, the desirability of considering this option.

The two factors which will most influence the economic feasibility of waste heat recovery are:

- Distance Between Diesel Sets and Load: The costs of insulated piping and trenching to transport hot water or glycol from the diesel sets to the building(s) where it will be used, can be as high as \$250/metre. Costs will of course vary depending on the difficulty of trenching (ie, bedrock, permafrost, etc.). Therefore, buildings in which diesel waste heat can be used, should be located as near to the diesel site as is possible.
- Nature of Heating Load: As discussed previously, there are two major sources of diesel waste heat that can be recovered - exhaust heat and coolant heat. Either one or both of these sources can be used. However, the cost of heat recovery equipment is about the same regardless of whether 100% or 10% of the heat content is to be used. Therefore all other factors being similar, the larger the amount of heat required (to the limit of that available) the more cost effective the installation.

A heat demand that exists throughout 12 months of the year (ie, hot water for laundry) is generally more economically attractive than one (ie, space heating) where the demand exists for only 6 or 8 months of the year.

Table 8.1 provides an approximate cost breakdown for a heat recovery system for a diesel set similar to those being installed in Sachigo and Bearskin. Column A shows the costs for a complete heat recovery system; column B is for coolant heat recovery only.

TABLE 8.1
APPROXIMATE COSTS
DIESEL HEAT RECOVERY SYSTEM

Expense Item	Complete Heat Recovery (A)	Coolant Heat Reco- very Only (B)
1. Exhaust heat recovery silencer diverter valve, pumps, controls, etc.	\$30,000	--
2. Jacket coolant heat exchanger pumps etc.	\$25,000	\$25,000
3. Installation Labour	<u>\$24,000</u>	<u>\$20,000</u>
TOTAL:	\$79,000	\$45,000

The above costs do not include the cost of transporting the heat recovery equipment (800-1000 kG or 1760-2200 lbs) or the cost of purchase, transport and installation of

pipng for the transfer of the hot water. Depending on distance, this cost, as presented previously, can add another \$30,000-\$50,000.

Preliminary economic assessments for application of waste heat recovery in Bearskin and Weagamow are presented below.

- 8.4.1 **Bearskin Lake:** Assuming that the average loading on the community power generators is about 125 KW, the potential contribution from a complete heat recovery system would be a continuous 135 KW (0.49 GJ/hr) or about 350 GJ/month (340 MM Btu/month).

The proposed fuel for heating water in the new complex is propane at an estimated delivered cost of \$38.88 per 100 lb. Assuming a heat value for propane of 2.05 GJ/100 lb (10.8×10^6 Kg-calories/metric tonne) and a propane burner efficiency of 75%, the cost of propane is \$19/GJ. The value of the waste heat available from the community power system is therefore about \$6600/month if both exhaust and jacket waste heat is recovered and \$3600/month if only jacket waste heat is recovered.

The estimated cost of propane for water heating, drying, and baking in the proposed laundromat, fitness centre, and bakery is about \$4200/month. About half of this amount, \$2000/month or \$24,000/year can be assumed to be for hot water and could be supplied from recovery of only the coolant heat.

Based on the general costs presented previously, Table 8.2 shows that the simple payback period is 4 years. Since annual maintenance costs are negligible and the lifespan of the system should be at least 10 or 15 years, then, after 4 years the heat is essentially "free". The potential savings in fuel costs over the life of the system are significant. Therefore it is recommended that a heat recovery system using only heat from the jacket coolant be considered for providing hot water in the community development centre.

TABLE 8.2
SIMPLE CALCULATION OF PAYBACK PERIOD
- Heat Recovery - Bearskin Lake -

1. <u>Initial Investment</u>		
- Equipment	\$45,000	
- Transfer Piping	<u>\$50,000</u>	
Total Investment		\$95,000
2. <u>Annual Propane Savings</u>		
		\$24,000
3. <u>Payback Period</u> = $\frac{\text{Initial Investment}}{\text{Annual Savings}}$		
	= $\frac{\$95,000}{\$24,000}$	
		= 4 years

8.4.2 Weagamow Lake: Although the Ontario Hydro diesel generators at Weagamow Lake are not identical to those of Bearskin and Sachigo, investment costs and available heat are sufficiently similar to assess, in preliminary fashion, the economic attractiveness of waste heat recovery in Weagamow Lake.

Assuming that the average loading of the Weagamow Lake community power system is 125 KW, then the potential contribution from a full heat recovery system would be a continuous 135 KW (465,000 Btu/hr) or about 350 GJ/month (340 MM Btu/month). The contribution from a jacket coolant heat recovery system would be about 190 GJ/month. If this waste heat were to be used to provide space heating to a garage or warehouse built adjacent to the community power system, the competing fuels would be oil or locally supplied wood. Assuming a fuel oil price of 65¢/litre, a fuel oil heat value of 3.8 GJ/100 litres, and a combustion efficiency of 65%, the cost of fuel oil derived heat is \$26/GJ. Assuming a fuel wood price of \$150/cord, a fuel wood heat value of 18 GJ/cord, and combustion efficiency of 50%, the cost of wood derived heat is \$17/GJ.

Any new commercial building constructed in Weagamow Lake should be built to much higher energy standards than current buildings (see Section 9). The demand for space heating in a building built to higher energy standards would be much less than is currently needed. The temperatures required to be maintained in a garage or warehouse would be also lower and this would make the demand even lower. Existing commercial buildings such as the Windigo community schools have an annual heating energy consumption of about 1.5 GJ/m^2 (see Appendix C). It is estimated that a new garage/warehouse could be constructed so that their annual fuel consumption, even in

a cold climate, is less than 1.0 GJ/m^2 of floor space (see Section 9).

The energy consumption of a new 170m^2 (1800 ft^2) warehouse and 230m^2 (2500 ft^2) garage would therefore be about 400 GJ/year . The annual savings from using recovered waste heat instead of oil would be \$10,400. The annual savings from using recovered waste instead of wood would be \$6,800.

It is therefore clear that there would be more than enough waste heat available from a simple jacket coolant recovery system to supply space heat to a 400m^3 energy efficient garage or warehouse.

The cost of installing jacket coolant heat exchangers on the three community power diesel generators, and supplying hot water heating to the new buildings through an above ground insulated piping system might be cheaper than the system recommended for Bearskin Lake because of the shorter pipe runs required. The total cost might be as follows:

Heat recovery system	\$45,000
Heat supply system	<u>\$20,000</u>
	\$65,000

The simple payback against oil is therefore about 6 years and about 9.5 years against wood.

8.5 Impacts

The major impacts resulting from implementation of this option is cost reduction for space heating (as described above).

8.6 Implementation Plan

At present, the potential applications of waste heat recovery (identified above) remain at a preliminary planning stage. Therefore, detailed recommendations with respect to implementation are not practical. However two general recommendations are important. These involve site selection and future technical assistance.

8.6.1 Site Selection: The importance of locating new buildings, capable of using diesel waste heat for space heating, close to (within 100 metres) the existing diesel sets can not be over emphasized. The new Ontario Hydro diesel sets in Bearskin and Sachigo have been designed to incorporate waste heat recovery equipment at a future date. However, the economic feasibility of using this waste heat will be jeopardized if the distance between the diesel sets and the potential load are greater than 100 metres. Site selection is therefore critical.

8.6.2 Future Technical Assistance: A final technical and economic assessment of the feasibility of waste heat recovery is possible only after some preliminary planning decisions such as building location and the size and nature of the energy demand has been established. In view of the potential benefits outlined above, it is recommended that a specific feasibility study be carried out, if and when these decisions have been reached. Two contacts are presented below who could provide advice.

Mr. Lorne Jeffers
Ontario Hydro
Thunder Bay, Ontario
1-807-344-2411

Conservation and Renewable
Energy Office
Energy, Mines and Resources Canada
Room 606
55 St. Clair Ave. East
Toronto, Ontario
1-416-252-5866
Attention: Head, Energy Project Management

SECTION 9

NEW COMMERCIAL BUILDINGS

9.1 Description of Current Situation

New commercial buildings are being planned in many of the Windigo communities. Based on site visit consultations they include the following:

Sachigo Lake:	Craft workshop and display area Tourist camp (1 building under construction) Laundromat Saw mill New health clinic New school
Bearskin Lake:	Community Economic Development Centre (laundromat, bakery, propane facility, fitness centre)
Weagamow Lake:	Garage Warehouse Community Gymnasium New school (K-G4) Laundromat New nursing station Co-op store
Cat Lake:	Gymnasium
Muskrat Dam:	Saw mill

Most of these buildings will be single storey buildings with floor areas between 100 and 400m² (1100 to 4300 ft²). The cost of shipping limits the type of construction that might be used to wood frame.

9.2 Description of Option

Opportunities exist to construct these new commercial buildings to energy efficiency standards almost as high as can be obtained in housing (see Section 3). By using the air sealing techniques described in Section 3 and by using higher insulation levels, a much more comfortable and energy efficient building can be constructed for a small additional cost. If full basements or crawl spaces are used, the buildings will also last much longer.

It is recommended that all new community buildings be designed in co-operation with an architect and builder who has first-hand experience with energy efficient building construction. Some of the features that should be used in new buildings include:

- continuous vapour barrier installed during construction
- insulation levels to at least RSI 7 (R40)
- high quality door and window units with good built-in weatherstripping
- large sliding doors (for garage, warehouse, etc.) that have special weatherstripping to minimize air infiltration when closed
- insulated pressure treated wood foundations with heated crawl space
- underpad insulation on garage or warehouse floors
- a wood heating system with oil back-up sized to match the lower heat requirements of the energy efficient building, or if appropriate, use of waste heat from

community power systems (see Section 8)

- "curtain wall" construction to enable fast closing in during construction while maintaining a continuous vapour barrier (see Section 3)
- single truss roofs which enable a continuous ceiling vapour barrier to be installed before construction of partition walls.

9.3 Technical Details

Technical details related to the above construction techniques and use of waste heat have been presented previously in Sections 3 and 8 respectively.

9.4 Estimated Cost and Savings

The estimated annual space heating requirements of existing commercial buildings such as schools, stores, nursing stations, etc. in the Windigo communities can be assumed to be about 1.5 GJ/m^2 (see Appendix C). This is equivalent to using about 60 litres of oil per year for each square metre of floor area (1.2 gallons per year per ft^2). In an energy efficient school, health centre, store, fitness centre, etc. built to include the above measures, the annual space heating requirements could be expected to be less than half the demand in current buildings; ie, about 0.75 GJ/m^2 . In an energy efficient warehouse or garage, where the necessity for large sliding doors, etc. would increase infiltration losses, the annual space heating requirements would be about 2/3 current demand (ie, about 1.0 GJ/m^2).

9.5 Impacts

The major impacts resulting from implementation of this

option are cost reduction for space heating (as described above) and increased comfort.

9.6 Implementation

A detailed implementation plan is not practical at this time, given the very preliminary stage of planning with respect to the commercial buildings identified above. Nonetheless, it is strongly recommended that, if and when a decision is made to pursue any of the above buildings, a budget be established within the total funding allocation for building design assistance.

Contact persons and firms capable of providing this service have been presented previously in Section 3.6 (New Housing).

SECTION 10

SUMMARY OF TECHNICAL OPTIONS

10.1 Summary

Based on the preceeding technical assessments, it is evident that several opportunities for energy conservation and oil substitution warrant consideration by the Windigo Tribal Council. Implementation of these options will not only save energy but, of equal or greater importance, they will contribute to more comfortable living conditions and employment development. Further, the implementation plans outlined for each option are not overly complex. In some cases, outside assistance is required to initiate the option, but thereafter existing community resources will, in most cases, be capable of managing and operating the identified options.

10.2 The Final Step

The discussions contained in Parts A and B of this report have addressed 3 key questions:

Question #1: What energy conservation/oil substitution options exist within the community?

Question #2: What are the technical, economic, social and environmental implications of each identified option? and

Question #3: How can the identified options be implemented and over what time period?

The final question to be addressed in this study is:

Question #4: Which options are most attractive to each community and should therefore be given highest priority?

The response to question #4 is the final step in the process of identifying a specific community energy plan. The following Part C of this report provides the Study Team's recommendations for each of the eligible communities.

PART C

COMMUNITY ENERGY PLANS

INTRODUCTION

Part C synthesizes the preceeding discussions into specific community energy plans.

The following community energy plans consider:

- community objectives as stated in Section 2.3
- RCDP objectives of reduced fuel oil consumption
- timing and community resource considerations

Options are recommended for short term and longer term application. Short term options are those considered ready for immediate action; longer term options are indicated where significant potential benefit exists but local conditions (ie, stage of planning, etc.) are not yet at a stage for immediate action. Nonetheless, consideration of these longer term options should be incorporated into future community plans.

In accordance with the scope of this contract, the community of Sachigo Lake is emphasized.

SECTION 11

SACHIGO COMMUNITY ENERGY PLAN

11.1 Recommended Options - Short Term

In Sachigo Lake, New Housing and Substitution of Wood For Oil in the School's Heating System were rated as the highest priority options.

The assessment of these 2 options indicates:

- both options effectively address community needs
- implementation of both options is timely
- the options are complementary and can be implemented in parallel.

New housing is, and will continue to be, a major focus in Sachigo. Further, there is strong interest in new energy efficient construction. Given this level of activity and interest, it is therefore timely that new energy efficient models be introduced into the construction schedule as soon as is possible. Similarly, major renovations and/or replacement of the school's heating system are being planned by DIAND. Again, it is therefore timely for the Band to present its request for a dual fuel heating system to DIAND.

Parallel implementation of these options is seen as being both practical and desirable. On the one hand, the options are sufficiently different in nature that different groups of residents would be required for each

and would therefore not result in unrealistic demands on a single group (ie, the experienced carpenters). On the other hand, parallel implementation would serve to minimize the increased demand on wood resources resulting from the substitution of wood for oil in the school's heating system. For example, if 4 new energy efficient homes are built instead of 4 conventional ones, it is estimated that the annual demand for wood fuel would be in the order of 8 cords for the 4 homes instead of a possible 30 to 40 cords. Hence the net savings would nearly equal and offset the increased wood harvest of approximately 35 cords per annum required to heat the school.

Although the Sachigo Band representatives did not rate highly the option of upgrading existing housing, the Study Team recommends that they at least consider trying 2 or 3 demonstrations. If the New Housing option is implemented as recommended, then there will be a unique and very low cost opportunity to gain the technical training through the supervision of the upgrading by the construction foreman who will be on site for the construction of the new housing.

A similar logical connection of options exists with respect to the school upgrading. It may be practical to request that the upgrading/conversion of the school's heating system be combined with improvements to the school's insulation and air sealing.

11.2 Other Options - Longer Term

The remaining options identified in Sachigo Lake all relate to new commercial buildings - either energy efficient design/construction and/or consideration of using recovered diesel waste heat (from Ontario Hydro sets) for space heating of a commercial building at the

airport. The Band is strongly encouraged to keep in mind the recommendations contained in Part B (Section 8 and 9), if and when these planned developments progress towards implementation.

11.3 Community Energy Plan Summary - Sachigo Lake

Year(s)

Action

1

- . Initiate New Housing Option. Select architect/buildings firm and finalize new house designs (see Section 3)
- . Initiate Wood Substitution in School Heating System. Request DIAND to specify replacement dual fuel wood/oil boiler and design boiler room modifications (see Section 7)
- . Consider including 2-3 demonstration of energy retrofit in existing housing as a component of the New Housing option above or as independent action (see Section 4).

2

- . Construct 3 or 4 demonstration new energy efficient homes using new designs and construction firm's foreman. Monitor buildings and identify any desired modifications
- . Retrofit 2 or 3 existing homes

- DIAND modifies boiler room and replaces current oil boiler in school with a dual fuel heating system and harvesting and sale of wood begins

- Establish schedule with DIAND for school upgrading (see Section 6)

3-5

- Construct all further new housing using new or modified energy efficient designs and techniques and local foreman
- Expand retrofit program and incorporate into ongoing renovation program making any modifications as necessary
- Continued harvesting and sale of wood to school
- If and when new commercial buildings are planned, ensure that energy efficient designs/construction techniques are pursued (Section 9) and waste heat recovery options are considered before design/siting are finalized (Section 8).

SECTION 12

BEARSKIN LAKE AND WEAGAMOW LAKE COMMUNITY ENERGY PLAN

12.1 Introduction

The recommended community energy plan for Bearskin Lake and Weagamow Lake are similar and are therefore presented together.

12.2 Recommended Options

The recommended options and rationale for Bearskin Lake and Weagamow Lake are essentially the same as for Sachigo, namely:

- New Housing
- Upgrading of Existing Housing
- Substitution of Wood for Oil in the School's Heating System
- Upgrading School Buildings

However, two further options are recommended in both Bearskin Lake and Weagamow Lake:

- Upgrading of Band Office
- Use of Waste Heat from Community Power Systems

Both Bearskin Lake and Weagamow Lake indicated interest in upgrading their respective Band offices. The Study Team's technical assessment of both situations indicated that relatively modest remedial measures would result in significant fuel savings and increased comfort.

Both Bearskin Lake and Weagamow Lake have also prepared feasibility studies for new commercial developments where the use of waste heat from the Ontario Hydro diesel sets for space heating warrant serious consideration. As these planned developments progress towards implementation, it is recommended that energy efficient construction techniques be used (see Section 9), and that waste heat recovery be seriously considered (see Section 8 - Waste Heat Recovery)

12.3 Community Energy Plan Summary - Bearskin Lake and Weagamow Lake

Year(s)	Action
1	. Initiate New Housing Option. Select architect/construction firm and finalize new house designs (see Section 3) . Initiate BCR to DIAND for Wood Substitution in school Heating System (Dual fuel wood/oil boiler replacement and boiler room modifications in Bearskin)(New wood fired boiler and new wood fired furnace in Weagamow)(see Section 7) . Consider including 2-3 demonstrations of energy retrofit in existing housing as component of New Housing option above or as independent action (see Section 4)

- . Implement renovations to Band offices (Furnace room modifications in Bearskin Lake)(New wood stoves in Weagamow)(see Section 5)
- . Carry out further studies on the feasibility and cost of using waste heat from community power systems for water heating in Bearskin Lake development centre and space heating in Weagamow airport commercial complex (see Section 8)
- . Construct 3 or 4 demonstration new energy efficient homes using new designs and construction firm foreman. Monitor results and identify any desired modifications
- . Retrofit 2 or 3 existing homes
- . Establish schedule with DIAND for conversion/upgrading of school buildings (see Section 6), for the installation of wood heating systems in schools and for Band harvesting and sale of wood (see Section 7)
- . Incorporate energy efficient building designs and construction techniques into the designs for the Bearskin Lake economic development centre and the Weagamow airport commercial complex. (see Section 9)

3-5

- . If shown to be economic and practical, incorporate waste heat recovery into the design of the Bearskin Lake economic development centre and the Weagamow airport commercial complex. (see Section 8)
- . Construct all further new housing using new or modified energy efficient designs and techniques
- . Expand retrofit program and incorporate into ongoing renovation program or modified on the basis of monitored results
- . Continued harvesting and sale of wood to school
- . As further new commercial buildings are planned, ensure that energy efficient designs/construction techniques are pursued (Section 9) and waste heat recovery options are considered before design/siting are finalized (Section 8).

SECTION 13

MUSKRAT DAM AND CAT LAKE COMMUNITY ENERGY PLAN

13.1 Introduction

The recommended community energy plan for Muskrat Dam and Cat Lake are similar and therefore presented together.

13.2 Recommended Options

The recommended options and rationale for Muskrat Dam and Cat Lake are essentially the same as for Sachigo, namely:

- New Housing
- Upgrading of Existing Housing
- Substitution of Wood For Oil in the School's Heating System (already implemented in Muskrat Dam)
- Upgrading School Buildings

In addition, both Muskrat Dam and Cat Lake have an immediate opportunity to incorporate planning for future waste heat recovery into their current community planning process. Both communities are currently in the process of developing their community site plans; as part of this exercise it is recommended that they request their respective planning consultants to consider the future application of diesel waste heat recovery within their final site layout recommendations (see Section 8).

When new commercial buildings reach the planning stage, energy efficient design/construction and/or the possibility of using recovered diesel waste heat for space heating, should be considered (see Sections 8 and 9).

13.3 Community Energy Plan Summary - Muskrat Dam and Cat Lake

Year(s)	Action
1	• Initiate New Housing Option. Select architect/construction firm and finalize new design (see Section 3) • In Cat Lake, initiate BCR to DIAND for Wood Substitution in School Heating System. (New wood furnace, ducting modifications, and furnace room modifications)(see Section 7) (in Muskrat Dam this option is being implemented) • Consider including 2-3 demonstrations of energy retrofit in existing housing as component for the New Housing option above or as an independent action (see Section 4) • Incorporate future diesel waste heat recovery potential into community site plan.
2	• Construct 3 or 4 demonstration new energy efficient homes using new designs and construction firm foreman. Monitor results and modify designs accordingly • Retrofit 2 or 3 existing homes

3-5

- . In Cat Lake, establish schedule with DIAND for upgrading of school buildings (see Section 6), for the installation of a wood heating system and for Band harvesting and sale of wood (see Section 7)
- . Construct all further new housing using new or modified energy efficient designs and techniques using local foreman
- . Expand retrofit program and incorporate into ongoing renovation program or modified on the basis of monitored results
- . Continued harvesting and sale of wood to school
- . If and when, new commercial buildings are planned, ensure that energy efficient designs/construction techniques are pursued (Section 9) and waste heat recovery options are considered before design/siting are finalized (Section 8).

SECTION 14**COMMUNITY ENERGY PLANS AND
THE WINDIGO TRIBAL COUNCIL****14.1 Further Considerations**

The preceeding community energy plans present both short term options for immediate implementation, and longer term options where it is important to ensure that appropriate planning occurs now so that future implementation will yield maximum benefits to the community.

There is significant overlap with respect to the short term options recommended in each community. This is to be expected given the relative similarity of facilities found in each community. From the perspective of the Windigo Tribal Council (as opposed to a single community) this overlap of options provides opportunity to achieve beneficial "economies of scale". For example, the cost of developing new house designs is approximately the same regardless of whether 4 or 40 houses are built from it. Spreading these design costs over 40 new houses will reduce them to a relatively minor cost; however, this scale is possible only at the Tribal Council level where the construction of 40 houses in one year is practical.

In a similar fashion, there may be advantages in coordinating and selectively demonstrating some of the above options among communities rather than each community pursuing their own independent path. The experience gained in one community can then be passed to another. Hopefully, this will help later implementations to avoid some of the inevitable problems that arise when something new is tried.

Finally, the Study Team understands that the Windigo Tribal Council will soon be hiring a Native engineer to oversee new capital projects. Hopefully, this report and the contacts mentioned in it, will be of particular benefit to this person.

Appendix A

Appendix A contains one calculation of heating requirements for the new house designs (#1, #2, #3) presented in Section 3.2. It is assumed that these houses are heated by wood.

Assumptions:

The calculations were based on the following inputs:

Wood cost = \$15.72 cu. meter. = \$56.90 a cord

50% efficiency of burn.

Design heat loss = -38°C

Climatological data for Big Trout Lake: [7680 degree days]

Design interior temp = 19°C average; basement = 15°C avg.

Allowable temperature swing = 5.5°C

Population 5 people @ 1.6 KWH/day each

Electric consumption = 14 KWH/day no hot water

Ventilation: .25 air ch/hr. + .25 air ch/hr. forced (heat exch)

Heating Summary:

The summary of the results were as follows:

House #1: Using wood @ 50% efficiency; uses 2.35 cords/year
= \$133.68 /yr.

House #2: Using wood @ 50% efficiency; uses 1.82 cords/year
= \$104.76 /yr.

House #3: Using wood @ 50% efficiency; = 1.65 cords per year
= \$94.45 per year.



SHELTER

CONSTRUCTION AND DEVELOPMENT LIMITED

2 LAKESHORE DRIVE, TORONTO M8V 1Y1
(416) 251-2111

* HOTCAN!
* NATIONAL RESEARCH COUNCIL OF CANADA *
* DIVISION OF BUILDING RESEARCH *
* SASKATOON, SASKATCHEWAN, 1982 *
* (RELEASE HOTCAN 4.01) *

141.

CLIENT NAME: WINDIGO
ADDRESS : SASHIGO LAKE ONTARIO

HOUSE MODEL 1

USER DATA FILE NAME: WINDIG,2

DATA IS FOR BIG TROUT LAKE

*** BUILDING PARAMETERS ***				
ELEMENTS	HOUSE VOLUME	AIR CHANGE	HT LOSS W/DEGC	% SEASONAL HT LOSS
VENTILATION	338.13 M3	.33/HR	33.9	37.54
	AREA M2	RSI VALUE M2-DEGC/W		
CEILING	71.58	7.04		
TOTAL	71.58	7.04	10.17	11.26
MAIN WALLS	70.80	7.04		
TOTAL	70.80	7.04	10.06	11.14
DOORS	1.70	1.30		
TOTAL	1.70	1.30	1.31	1.45
BASEMENT AB.GD	16.53	4.90		
TOTAL	16.53	4.90	3.37	3.74
BASEMENT 600MM	21.70	4.90		
TOTAL	21.70	4.90	3.82	1.50
BASE. TO FLOOR	48.70	4.90		
TOTAL	48.70	4.90	7.99	3.13
FLOOR PERIMETER	29.67	2.00		
TOTAL	29.67	2.00	8.01	3.14
FLOOR CENTRE	41.90	2.00		
TOTAL	41.90	2.00	7.97	3.12
SOUTH WINDOWS	9.00	.54		
TOTAL	9.00	.54	16.67	18.46
NORTH WINDOWS	1.80	.54		
TOTAL	1.80	.54	3.33	3.69
EAST WINDOWS	.00	.00		
TOTAL	.00	.00	.00	.00
WEST WINDOWS	.90	.54		
TOTAL	.90	.54	1.67	1.85

HOTCAN

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S-EAST WINDOWS	.00	.00		
TOTAL	.00	.00	.00	.00
S-WEST WINDOWS	.00	.00		
TOTAL	.00	.00	.00	.00

ADDRESS : SASHIGO LAKE ONTARIO

DESIGN HEAT LOSS AT -38C = 5.06 KW
 DEGREE DAYS FOR BIG TROUT LAKE IS 7680
 TEMPERATURES (DEG C) MAIN FLOOR = 19 BASEMENT = 11
 SENSIBLE HEAT GAIN FROM PEOPLE (KWH/D) = 8
 DAILY BASE ELECTRIC CONSUMPTION (KWH/D) = 14
 DAILY HOT WATER ENERGY CONSUMPTION (KWH/D) = 0
 MASS LEVEL CHOSEN IS (A)
 BASEMENT INSULATED PRIMARILY FROM THE INSIDE
 WINDOW SHADING COEFFICIENTS: SOUTH = .8 NORTH = .8
 EAST = 0 WEST = .8
 S-EAST = 0 S-WEST = 0
 SOUTH OVERHANG GEOMETRY: AVERAGE WINDOW HEIGHT = 1.21 M
 AVERAGE OVERHANG WIDTH = .3 M
 AVERAGE HEIGHT ABOVE WINDOW = 0 M
 NATURAL INFILTRATION RATE (AC/HR) = .25
 FORCED VENTILATION RATE (AC/HR) = .25
 HEAT RECOVERY EFFECTIVENESS ON VENTILATION AIR = 70 %

*** MONTHLY SUMMARY OF ENERGY CONSUMPTION ***

MONTH	THERMAL LOAD KWH/D	MONTHLY SOLAR FRAC	AUX HEAT REQ KWH/D	TOT CONS KWH/D
JAN	69.43	.29	49.40	63.40
FEB	63.88	.42	37.06	51.06
MAR	58.29	.44	28.29	42.29
APR	28.72	.69	8.85	22.85
MAY	11.38	.91	.99	14.99
JUN	.00	1.00	.00	14.00
JUL	.00	1.00	.00	14.00
AUG	.00	1.00	.00	14.00
SEP	1.86	1.00	.00	14.00
OCT	14.94	.66	5.14	19.14
NOV	37.10	.30	25.82	39.82
DEC	59.50	.25	44.37	58.37

*** YEARLY ENERGY CONSUMPTION COMPARISONS ***

12 MONTH HEATING SEASON IN EFFECT
 ANNUAL SOLAR HEATING CONTRIBUTION = 41 %

ESTIMATED ANNUAL SPACE HEATING 21 GJ, OR	6,051 KWHRs
SEEH PROGRAM ENERGY BUDGET FOR SPACE HEATING =	8,466 KWHRs

PREDICTED ANNUAL AUXILIARY ENERGY CONSUMPTION =	5,110 KWHRs
SEEH PROGRAM AUXILIARY ENERGY CONSUMPTION =	10,600 KWHRs

TOTAL ANNUAL ENERGY CONSUMPTION =	11,161 KWHRs
TOTAL ANNUAL SEEH PROGRAM ENERGY BUDGET =	19,066 KWHRs

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*** ANNUAL PREDICTED FUEL COSTS ***

FUEL COSTS ARE FOR ONTARIO

AS OF 83/06/22

ENERGY SOURCE	COST PER UNIT	SPACE HEATING	HOT WATER	LIGHTS AND APPLIANCES
WOOD	15.72/M3	\$ 133.68/YR EFF.= 50% = 2.35 cords	\$ 0/YR EFF.= 40%	

This estimate of energy demand may not reflect actual energy requirements of a house due to variations in weather, performance of equipment, and the lifestyle of the occupants.



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* DIVISION OF BUILDING RESEARCH *
* SASKATOON, SASKATCHEWAN, 1982 *
* (RELEASE HOTCAN 4.01) *

HOUSE MODEL 2

CLIENT NAME: WINDIGO
ADDRESS : SASHIGO LAKE ONTARIO

USER DATA FILE NAME: WINDIG-2,2

DATA IS FOR BIG TROUT LAKE

*** BUILDING PARAMETERS ***				
ELEMENTS	HOUSE VOLUME	AIR CHANGE	HT LOSS W/DEGC	% SEASONAL HT LOSS
VENTILATION	263.3 M3	.33/HR	26.4	32.27
	AREA M2	RSI VALUE M2-DEGC/W		
CEILING	55.74	7.05		
TOTAL	55.74	7.05	7.91	9.67
MAIN WALLS	60.63	7.04		
TOTAL	60.63	7.04	8.61	10.53
DOORS	1.70	1.30		
TOTAL	1.70	1.30	1.31	1.60
BASEMENT AB.GD	13.60	4.90		
TOTAL	13.60	4.90	2.78	3.39
BASEMENT 600MM	18.20	4.90		
TOTAL	18.20	4.90	3.21	2.10
BASE. TO FLOOR	41.03	4.90		
TOTAL	41.03	4.90	6.79	4.44
FLOOR PERIMETER	25.18	2.00		
TOTAL	25.18	2.00	7.00	4.58
FLOOR CENTRE	30.56	2.00		
TOTAL	30.56	2.00	5.81	3.80
SOUTH WINDOWS	9.50	.54		
TOTAL	9.50	.54	17.59	21.51
NORTH WINDOWS	.90	.54		
TOTAL	.90	.54	1.67	2.04
EAST WINDOWS	.90	.54		
TOTAL	.90	.54	1.67	2.04
WEST WINDOWS	.90	.54		
TOTAL	.90	.54	1.67	2.04

HOTCAN

PAGE 2

S-EAST WINDOWS	.00	.00		
TOTAL	.00	.00	.00	.00
S-WEST WINDOWS	.00	.00		
TOTAL	.00	.00	.00	.00

ADDRESS : SASHIGO LAKE ONTARIO

DESIGN HEAT LOSS AT -38C = 4.45 KW
 DEGREE DAYS FOR BIG TROUT LAKE IS 7680
 TEMPERATURES (DEG C) MAIN FLOOR = 19 BASEMENT = 15
 SENSIBLE HEAT GAIN FROM PEOPLE (KWH/D) = 8
 DAILY BASE ELECTRIC CONSUMPTION (KWH/D) = 14
 DAILY HOT WATER ENERGY CONSUMPTION (KWH/D) = 0
 MASS LEVEL CHOSEN IS (A)
 BASEMENT INSULATED PRIMARILY FROM THE INSIDE
 WINDOW SHADING COEFFICIENTS: SOUTH = .8 NORTH = .8
 EAST = .8 WEST = .8
 S-EAST = 0 S-WEST = 0
 SOUTH OVERHANG GEOMETRY: AVERAGE WINDOW HEIGHT = 1.2 M
 AVERAGE OVERHANG WIDTH = .3 M
 AVERAGE HEIGHT ABOVE WINDOW = 0 M
 NATURAL INFILTRATION RATE (AC/HR) = .25
 FORCED VENTILATION RATE (AC/HR) = .25
 HEAT RECOVERY EFFECTIVENESS ON VENTILATION AIR = 70 %

*** MONTHLY SUMMARY OF ENERGY CONSUMPTION ***

MONTH	THERMAL LOAD KWH/D	MONTHLY SOLAR FRAC	AUX HEAT REQ KWH/D	TOT CONS KWH/D
JAN	59.01	.35	38.14	52.14
FEB	54.20	.41	31.91	45.91
MAR	42.44	.51	21.00	35.00
APR	23.78	.62	9.14	23.14
MAY	8.00	1.00	.02	14.02
JUN	.00	1.00	.00	14.00
JUL	.00	1.00	.00	14.00
AUG	.00	1.00	.00	14.00
SEP	.64	1.00	.00	14.00
OCT	11.94	.77	2.71	16.71
NOV	31.10	.38	19.42	33.42
DEC	50.45	.31	34.65	48.65

*** YEARLY ENERGY CONSUMPTION COMPARISONS ***

12 MONTH HEATING SEASON IN EFFECT
 ANNUAL SOLAR HEATING CONTRIBUTION = 44 %

ESTIMATED ANNUAL SPACE HEATING 17 GJ, OR 4,742 KWHRS
 SEEH PROGRAM ENERGY BUDGET FOR SPACE HEATING = 6,593 KWHRS

PREDICTED ANNUAL AUXILIARY ENERGY CONSUMPTION = 5,110 KWHRS
 SEEH PROGRAM AUXILIARY ENERGY CONSUMPTION = 10,600 KWHRS

TOTAL ANNUAL ENERGY CONSUMPTION = 9,852 KWHRS
 TOTAL ANNUAL SEEH PROGRAM ENERGY BUDGET = 17,193 KWHRS

HOTCAN

PAGE 3

*** ANNUAL PREDICTED FUEL COSTS ***

FUEL COSTS ARE FOR ONTARIO

AS OF 83/06/22

ENERGY SOURCE	COST PER UNIT	SPACE HEATING	HOT WATER	LIGHTS AND APPLIANCES
WOOD	15.72/M3	\$ 104.76/YR EFF.= 50% = 1.92 cords	\$ 0/YR EFF.= 40%	

This estimate of energy demand may not reflect actual energy requirements of a house due to variations in weather, performance of equipment, and the lifestyle of the occupants.



SHELTER

CONSTRUCTION AND DEVELOPMENT UNIT

9 LAKESHORE DRIVE, TORONTO M8V 1Y
(416) 251-2111

 * NATIONAL RESEARCH COUNCIL OF CANADA *
 * DIVISION OF BUILDING RESEARCH *
 * SASKATOON, SASKATCHEWAN, 1982 *
 * (RELEASE HOTCAN 4.01) *

CLIENT NAME: WINDIGO
 ADDRESS : SASHIGO LAKE ONTARIO

HOUSE MODEL 3

USER DATA FILE NAME: WINDIG-3,2

DATA IS FOR BIG TROUT LAKE

ELEMENTS	*** BUILDING PARAMETERS ***		HT LOSS W/DEGC	% SEASONAL HT LOSS
	HOUSE VOLUME	AIR CHANGE		
VENTILATION	254.6 M3	.33/HR	25.52	33.88
	AREA M2	RSI VALUE M2-DEGC/W		
CEILING	53.90	7.04		
TOTAL	53.90	7.04	7.66	10.16
MAIN WALLS	62.80	7.04		
TOTAL	62.80	7.04	8.92	11.84
DOORS	1.70	1.30		
TOTAL	1.70	1.30	1.31	1.74
BASEMENT AB.GD	17.80	4.90		
TOTAL	17.80	4.90	3.63	4.82
BASEMENT 600MM	17.80	4.90		
TOTAL	17.80	4.90	3.14	1.47
BASE. TO FLOOR	34.40	4.90		
TOTAL	34.40	4.90	5.75	2.70
FLOOR PERIMETER	25.18	2.00		
TOTAL	25.18	2.00	7.00	3.29
FLOOR CENTRE	28.74	2.00		
TOTAL	28.74	2.00	5.46	2.57
SOUTH WINDOWS	8.50	.54		
TOTAL	8.50	.54	15.74	20.89
NORTH WINDOWS	.90	.54		
TOTAL	.90	.54	1.67	2.21
EAST WINDOWS	.90	.54		
TOTAL	.90	.54	1.67	2.21
WEST WINDOWS	.90	.54		
TOTAL	.90	.54	1.67	2.21

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PAGE 2

S-EAST WINDOWS	.00	.00		
TOTAL	.00	.00	.00	.00
S-WEST WINDOWS	.00	.00		
TOTAL	.00	.00	.00	.00

ADDRESS : SASHIGO LAKE ONTARIO

DESIGN HEAT LOSS AT -38C = 4.24 KW
 DEGREE DAYS FOR BIG TROUT LAKE IS 7680
 TEMPERATURES (DEG C) MAIN FLOOR = 19 BASEMENT = 11
 SENSIBLE HEAT GAIN FROM PEOPLE (KWH/D) = 8
 DAILY BASE ELECTRIC CONSUMPTION (KWH/D) = 14
 DAILY HOT WATER ENERGY CONSUMPTION (KWH/D) = 0
 MASS LEVEL CHOSEN IS (A)
 BASEMENT INSULATED PRIMARILY FROM THE INSIDE
 WINDOW SHADING COEFFICIENTS: SOUTH = .8 NORTH = .8
 EAST = .8 WEST = .8
 S-EAST = 0 S-WEST = 0
 SOUTH OVERHANG GEOMETRY: AVERAGE WINDOW HEIGHT = 1.2 M
 AVERAGE OVERHANG WIDTH = .3 M
 AVERAGE HEIGHT ABOVE WINDOW = 0 M
 NATURAL INFILTRATION RATE (AC/HR) = .25
 FORCED VENTILATION RATE (AC/HR) = .25
 HEAT RECOVERY EFFECTIVENESS ON VENTILATION AIR = 70 %

*** MONTHLY SUMMARY OF ENERGY CONSUMPTION ***

MONTH	THERMAL LOAD KWH/D	MONTHLY SOLAR FRAC	AUX HEAT REQ KWH/D	TOT CONS KWH/D
JAN	54.50	.35	35.60	49.60
FEB	49.80	.41	29.51	43.51
MAR	38.35	.51	18.92	32.92
APR	20.23	.64	7.34	21.34
MAY	5.70	1.00	.00	14.00
JUN	.00	1.00	.00	14.00
JUL	.00	1.00	.00	14.00
AUG	.00	1.00	.00	14.00
SEP	.00	1.00	.00	14.00
OCT	8.83	.85	1.36	15.36
NOV	27.43	.38	16.90	30.90
DEC	46.21	.31	31.94	45.94

*** YEARLY ENERGY CONSUMPTION COMPARISONS ***

12 MONTH HEATING SEASON IN EFFECT
 ANNUAL SOLAR HEATING CONTRIBUTION = 44 %

ESTIMATED ANNUAL SPACE HEATING	15 GJ, OR	4,275 KWHRS
SEEH PROGRAM ENERGY BUDGET FOR SPACE HEATING =		6,375 KWHRS

PREDICTED ANNUAL AUXILIARY ENERGY CONSUMPTION =	5,110 KWHRS
SEEH PROGRAM AUXILIARY ENERGY CONSUMPTION =	10,600 KWHRS

TOTAL ANNUAL ENERGY CONSUMPTION =	9,385 KWHRS
TOTAL ANNUAL SEEH PROGRAM ENERGY BUDGET =	16,975 KWHRS

HOTCAN

PAGE 3

*** ANNUAL PREDICTED FUEL COSTS ***

FUEL COSTS ARE FOR ONTARIO

AS OF 83/06/22

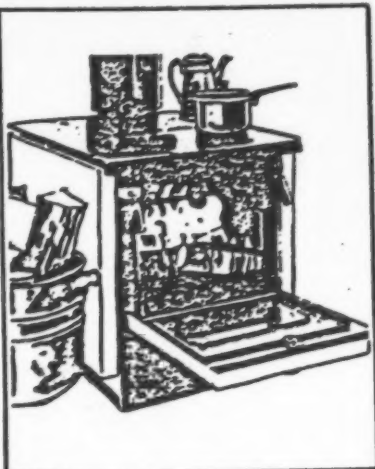
ENERGY SOURCE	COST PER UNIT	SPACE HEATING	HOT WATER	LIGHTS AND APPLIANCES
WOOD	15.72/M3	\$ 94.45/YR EFF.= 50% =1.65 CORDS	\$ 0/YR EFF.= 40%	

This estimate of energy demand may not reflect actual energy requirements of a house due to variations in weather, performance of equipment, and the lifestyle of the occupants.

APPENDIX B
PARTIAL LIST OF EFFICIENT
WOODSTOVES

Source: Home Energy Guide Vol. 2, No. 9. Winter 1983, Fennwood Publishing
Scarborough, Ont.

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R.S.F. Energy's revolutionary combustion principle, using a down feed progressive cross-draft system, offers a heating unit which is not only highly efficient, but extremely controllable.

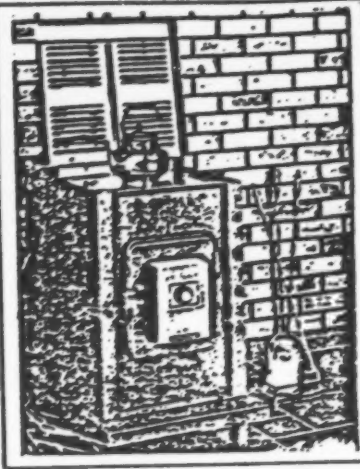
Primary combustion air, controlled automatically by a die-cast aluminum inlet with a sealed tamper proof bimetallic thermostat in the unit, is distributed along the total length of each side of the brick lined firebox.

This is a "progressive cross-draft system". During the burning process, smoke and combustible gases are forced to flow downward through the fire. This is a "down feed" or "down draft system". These systems, combined with continuous introduction of sufficient amount of flaming hot secondary air, to mix with the combustible gases for the "after-burn", produces a highly efficient burning process.

Options are: Domestic hot water heating coils, remote wall thermostat and screens. The R.S.F. is certified for regular and mobile home installation. For more information see R.S.F. Energy ad on page 43.

Specifications:

Height	72cm (28½ in.)
Width	61 cm (24 in.)
Depth	71 cm (27½ in.)
Flue size	17 cm (7 in.)
C.O.S.P. Acceptance	No. WCG 001



If you are looking for an inexpensive but well built (and efficient) heating appliance, you should consider the Super Chalet Model WC220. It has a heavy cast iron flue collar for long life, while the cabinet is made of zinc-coated steel to resist rust and corrosion, and is finished in a temperature-resistant metallic grey. The Chalet has a front loading hearth and door which has an adjustable automatic thermostat control and draft control mounted on it. It's "V" shaped firebox is constructed of heavy gauge steel and is firebrick lined.

The stainless steel flue baffle provides increased efficiency by deflecting combustion gases back into the fire. The baffle also helps keep heat inside the stove for radiation into the room, rather than allowing it to escape up the chimney.

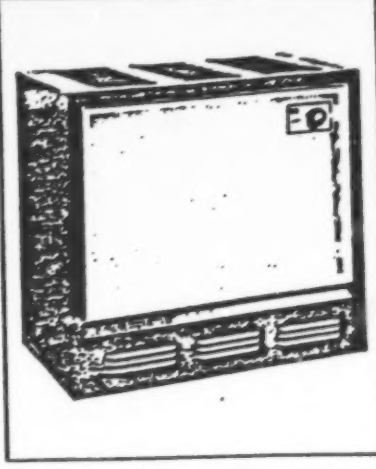
The top of the cabinet may be lifted to allow the stainless steel top of the fire chamber to be used for cooking. This top is louvered to direct warm air forward and the sides.

For added strength the Super Chalet has triple wall construction at the back of the unit.

An ash shovel and poker are included as standard equipment.

Specifications:

Height	76 cm. (30 in.)
Width	48 cm. (19 in.)
Depth	74 cm. (29 in.)
Flue size	15 cm. (6 in.)
C.O.S.P. Acceptance	No. WCH 113



Both these CSA-certified wood burners offer the user large fireboxes capable of taking 60 cm (24 in.) logs and are designed for long burn times and few refuellings. The WC 100 C offers a firebrick lining for long life and heat retention. The WC 50 CC Deluxe has a cast iron lining for maximum heat output.

Capable of heating up to five average rooms, the WC 50 CC Deluxe has an automatic, non-electric thermostat control to maintain an even room temperature. Economy is the major advantage of this large model. The manufacturer states that it uses one-third less wood than conventional wood stoves when operating at peak efficiency.

The units maintain an aesthetically pleasing appearance because the heavy gauge-wall steel fuel and ash doors are on the side, hidden by the outer cabinet doors. The grates and flue collars are made of cast iron to ensure a long, trouble free lifespan.

An optional blower is available that forces air out of the units at floor level, to heat the floor for barefoot comfort. It fits into standard outlets and can be either manually or thermostatically controlled.

The units are finished in dark brown enamel baked onto a zinc coated steel.

Specifications:

Height	84 cm. (33 in.)
Width	81 cm. (32 in.)
Depth	48 cm. (19 in.)
Flue size	15 cm. (6 in.)
C.O.S.P. Acceptance	No. WCH 032


Manufactured By:

George A. Harding Limited
61 Tolson Rd.
Markham, Ontario L3R 1E4
(416) 475-1531

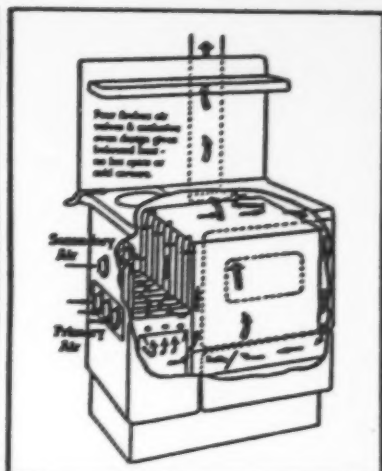
R.S.F. Energy Ltd.
Box 267
Smithton, B.C. V0B 2P0

Manufactured by:

Hevac-Fireplace Furnace Mfg. Ltd.,
4390 Paletta Court,
Burlington, Ontario L7L 4X5
(416) 275-7144 (416) 632-4710

Manufactured by:

Hevac-Fireplace Furnace Mfg. Ltd.,
4390 Paletta Court,
Burlington, Ontario L7L 4X5
(416) 275-7144 (416) 632-4710



First introduced way back in 1933 the Savoy has literally been built in the tens of thousands. Although little refinements have been made the basic appliance has been well tried and tested. It offers efficient space heating, water heating and cooking. A polished cast iron cooking surface on the stove top plus a glass doored oven with a thermometer which is finished in porcelain enamel.

The oven is of large dimensions giving a family-sized cooking appliance. An efficient cast iron water font can supply all your domestic hot water, and radiators can be installed for heating adjoining rooms. In addition a glass lined water reservoir tank is available for clean water heating, storage and humidifying. The Savoy is capable of achieving oven temperatures of 205°C (400°F) within 30 minutes of starting the fire.

The new combustion controlled fire-box is lined with chrome casting to ensure a considerably longer life than regular castings. Combustion air is controlled by one secondary and three primary air valves, conveniently located on the left hand side of the stove. The Savoy is eligible for the C.O.S.P. grant and is available in porcelain enamel finishes of white and almond.

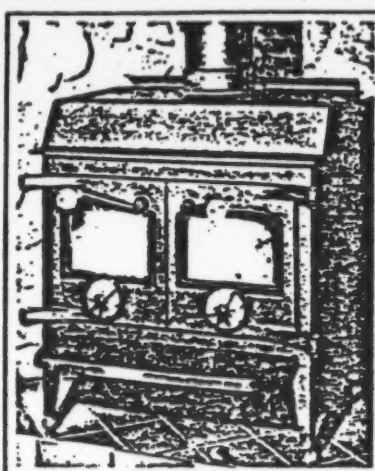
Specifications:

Height 82 cm (32½ in)
Width 81 cm (32 in)
Depth 77 cm (30½ in)
Flue Size 18 cm (7 in)

C.O.S.P. Acceptance

Model "53" WWE068

Model "53T" WCE070



Several interesting features make up the Beaumont package. The doors on each unit may be fitted with either high temperature heat resistant glass, or interchangeable decorative cast iron panels.

They are available in black or brown with brass highlights on the spin draft controls; though the standard model comes with wooden handles, brass plated handles are available as an option.

In order to give greater flexibility in choosing a location for the appliance in your residence, the Beaumont is constructed in such a way as to require as little as a 25 cm (10 in) clearance from combustible walls. The Beaumont's firechamber is lined with firebrick to prevent burnout and hold the heat in the combustion area which results in increased combustion efficiency.

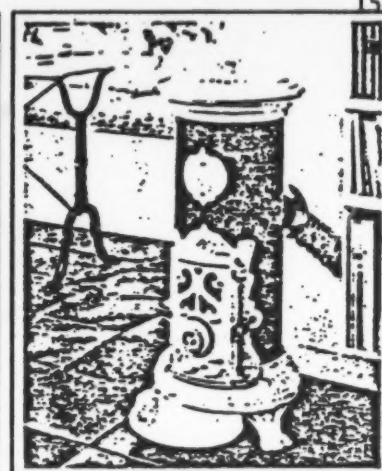
A removable baffle, a unique metal fibre seal, and an accurate draft control also play a role in making this unit an efficient heater.

Appalachian, Laurentian, and Acadian are the names given to the stoves in the Beaumont series. All are covered by a five year warranty.

Specifications:

Height 81 cm (32 in)
Width 76 cm (30 in)
Depth 72 cm (28½ in)
Flue size 18 cm (7 in)

C.O.S.P. Acceptance No. WUO 026-7-8



Built in Guise, France, the Godin model 3721 has an estimated output of 30,000 B.T.U.'s/hour. Its body is made of steel and lined with firebricks. The top, firedoor, ash catcher and legs are made of cast iron. These portions of the stove are finished in vitreous enamel in a choice of attractive colours.

This model and the smaller model 3720 are designed to burn both wood and coal. The smaller model was tested by Britain's National Coal Board in 1975 and was given an efficiency rating of 72 percent. A major reason for this efficiency is the preheating of secondary air to a secondary combustion zone. Combustion is controlled by a spin draft control. The Godins size and shape allow easy installation in a variety of locations, the smaller version is ideal for fireplace installations.

Godin stoves are amazingly durable, too. Many have been in continuous use for 100 years.

Specifications:

Height 99 cm (39 in)
Width 53 cm (21 in)
Depth 69 cm (27 in)
Flue size 13 cm (5 in)

C.O.S.P. Acceptance No. WCM 012



Distributed by:

Marsh's Stoves

3322 Dundas St. W.

Toronto, Ontario M6P 2A4

(416) 762-4582

Manufactured by:

Old Timer Stove Company Inc.

57 Edwin St.

Kitchener, Ontario N2H 4N7

(519) 742-0611

Distributed by:

Manitoba and East

Tri-Lane Distributing Ltd.

R.R.4, Tottenham

Ottawa, L8G 1W0

(416) 936-3254

Southwestern and West

Midco Industries Ltd.

P.O. Box 91686

West Vancouver, B.C. V7V 3P3

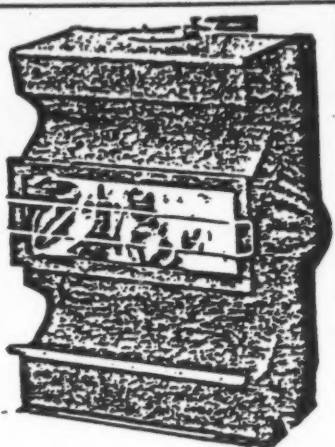
(604) 980-7116

HARTHEX

HERITAGE

HURRICANE

153



The Harthex is a truly designed stove. Its unique sculptured shape gives it not only a timeless elegance, but also great strength and fuel efficiency.

Harthex is a system. A system based on one size stove. Small and safe, but powerful, it produces up to 30,000 BTU/hr. Efficient and versatile with a full range of options - making it adaptable to both fireplace conversions and freestanding installations.

The Harthex features a "full width" front door with Neoceram safety glass. By an ingenious (and patented) use of the fire itself, this window stays clean longer than those in most other stoves.

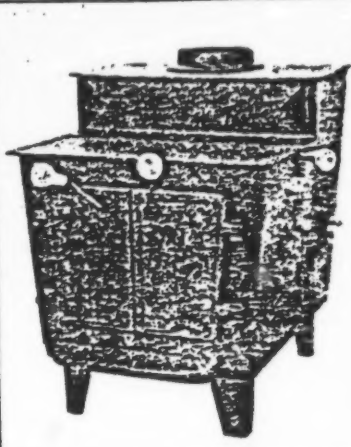
This high quality appliance is now available in a Zero-Clearance version, which utilizes a unique hollow metal floor protection system. All units are either ULC or Warnock Hersey listed and are available directly from the manufacturer or through authorized dealers.

For more information, please see the back page of this guide.

Specifications:

Height 64 cm (25 in.)
Width 45 cm (18 in.)
Depth 28 cm (11 in.)
Flue Size 10 cm (4 in.)

C.O.S.P. Acceptance No.s
WUM 091, WWM 092



Heritage side draft wood stoves have been rated by the Canadian Combustion Research Laboratory of the Ministry of Energy, Mines and Resources in Ottawa as the most efficient wood stove manufactured in Canada.

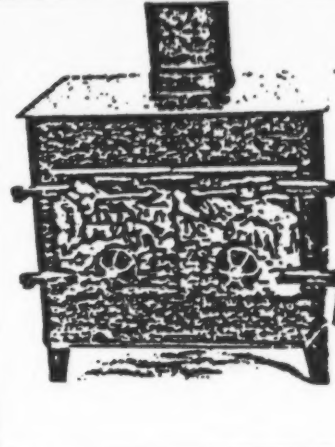
The Heritage side draft gives twice the burn for your money. It is fired in the conventional updraft mode but by repositioning the internal damper it is converted to its base burning side draft mode. This allows the wood to be burned in the rear secondary combustion chamber and at the same time, the gases to be burned in the rear secondary combustion chamber. It is in this position that the greatest wood burning efficiencies are realized.

The Heritage 24 is made with heavy cast iron doors completely gasketed to insure a proper seal. Door adjustments are made easily by the use of an adjustable latching mechanism. Cleaning of ash from the tray in front is facilitated by the removable ash tray. The double bottom and back allows for the attachment of an optional blower to move heat around the room.

Specifications:

Height 70 cm (28 in.)
Width 64 cm (25 in.)
Depth 69 cm (27 in.)
Flue Size 17 in (7 in.)

C.O.S.P. Acceptance No. WCH 077



New from Fresh Air Fireplaces of Canada, is the Hurricane model 300 which features an automatic draft, arched ceramic glass doors and over 740 square centimeters (115 sq. in.) of fire visibility.

A unique blower system (Patent Pending) on each Hurricane stove draws cool air from the floor into a heat chamber at the back of the stove. There it is warmed as its travels upward and through a double row of heat tubes; then it is blown into the home through the front of the stove.

For increased efficiency, an outside air kit will draw circulating air from outside the house. This Hurricane feature increases the volume of heated air and pressurizes your home (by circulating the increased air volume through paths of least resistance) for more even heat distribution.

Water heating coils in the heat chamber may be connected to your hot water system, and will circulating hot water through the system by convection.

Aesthetically, each Hurricane stoves features a sculptured door, or set of doors, with the artwork cast in relief. Popular models feature a mountain/wildlife scene.

The most popular Hurricane stove is finished in high heat warm brown and trimmed in Brass. Satin black and other colours are also available. Hurricane stoves are also covered by a five year warranty.

Specifications for the model 300:

Height 69 cm (27 in.)
Width 74 cm (29 in.)
Depth 64 cm (25 in.)
Flue size 20 cm (8 in.)

C.O.S.P. Acceptance No. WWF 145



Manufactured by:
Harthex Home Woodstoves
256 Woodlawn Rd. W.
Guelph, Ontario, N1H 6J4
(519) 837-3200

Manufactured By:
Heritage Energy Systems
23 Balsam Street
Collingwood, Ontario L9Y 4H7
(705) 445-5650

Manufactured by:
Fresh Air Fireplaces of Canada Ltd.
1215 Meyerside Dr., Unit B-9 1227-38th Avenue, N.E.
Mississauga, Ontario, L5T 1H3 Calgary, Alberta, T2E 6M3
(416) 678-8443 (403) 250-2530

JØTUL

Old Timer

SUNRIDGE

154



Based on North American design circa 1750 the Jotul No.8 displays a classic elegant look which surrounds a modern efficient combustion system.

The Jotul Colonial Fireplace Stove allows air to enter the firebox from two directions for more efficient combustion. Primary air goes directly to the fire. Secondary air flows under the bottom burn plate and enters the firebox from behind. There as it passes above the hottest part of the fire, it kindles unburned gases that have been released by the burning wood. The result: more complete combustion, more heat from your wood, better fuel economy.

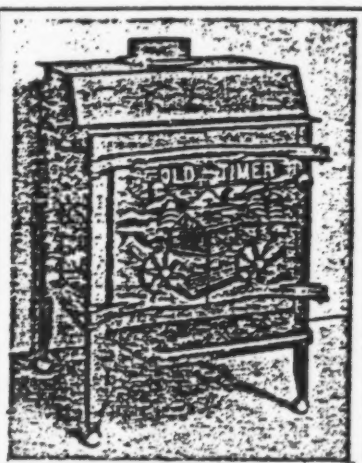
The Jotul No.8 can be used either as an efficient, controlled combustion stove with fire viewing through heat resistant glass panels, or as a beautiful open door fireplace using the easily inserted fire-screen.

Options include an attractive very dark blue porcelain enamelled finish. This hard surface requires virtually no maintenance. It won't discolour and is easy to clean with a damp cloth.

Although the standard unit is easily installed in front of an existing fireplace, for very low situations shorter legs which reduce the height by 2½ inches are available.

Specifications:

Height	75 cm (29½ in)
Width	69 cm (27 in)
Depth	45 cm (17 in)
Flue Size	18 cm (7 in)
C.O.S.P. Acceptance	No. WU 019



The Old Timer offers durable construction and innovative design.

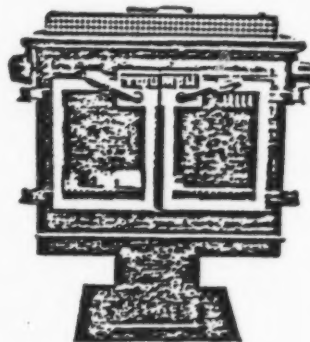
The heavy cast iron doors which are interestingly decorated with a log cabin and mountain scene are designed not to warp and are hand molded to ensure excellent castings. A non-asbestos door seal ensures an airtight fit. The attractive wood handles are cooler to touch. And two spin draft controls allow accurate and easy adjustments of the combustion air flow.

The carefully engineered and positioned baffle deflects unburned gases back to the fire for more efficient combustion. This baffle is removable if it needs replacing or cleaning. If one wishes to view the fire the doors can be left open and the fire can be viewed through a metal spark screen.

The Old Timer comes in three fireplace/stove models. All are warranted for five years against all defects.

Specifications:

Two-door OT III: fireplace/stove	
Height	81.5 cm (32 in)
Width	61 cm (24 in)
Depth	66 cm (26 in)
Flue size	15 cm (6 in)
C.O.S.P. Acceptance	No. WUO 023



The Sundridge is one of a range of appliances manufactured under the Triumph name.

It is ruggedly constructed with a 5/16" thick steel top and 1/4" - thick steel side. The Firechamber is lined with firebrick and has a baffle and smoke roll deflector. Combustion air is controlled through two spindraft controls located on the side of the unit.

This combustion air control also acts as an "air wash" to keep the glass cleaner.

The decorative double doors are manufactured of high quality cast iron with attractive brushed brass or 24 karat gold highlights.

The see-through doors are the finishing touch to what is a very decorative and efficient solid-fuel-burning appliance. It is available in either black, metallic brown or midnight brown finishes.

The efficiency of this unit may be further improved with the optional blower which comes complete with a variable speed control.

Specifications:

Height	69 cm (27 in)
Width	74 cm (29 in)
Depth	65 cm (25½ in)
Flue size	20 cm (8 in)
C.O.S.P. Acceptance	No. WWT 074



Distributed by:

Cordylne Enterprises Ltd.
575 Wellington St.W.
Toronto, Ontario M5V 1G3
(416) 366-6782

Manufactured by:

Old Time Stove Co. Inc.
57 Edwin St.
Kitchener, Ontario, N2H 4N7
(519) 742-0611

Manufactured by:

Triumph Energy Products
1990 Edmore Road, Unit 6
Scarborough, Ontario, M1N 2W2
(416) 431-8238
Triumph Forge King Ltd.
P.O. Box 1430
Morden, Manitoba, R6G 1B9
(204) 822-4467
(204) 284-7915 Winnipeg

APPENDIX C

ENERGY AUDIT FOR SACHIGO SCHOOL

Building Features

Walls (above grade):	Wood frame 2x4 with RSI 2.1 (R12) insulation plus panelling/siding. Area(excl. windows & doors) 190m ² Total insulation value RSI 2.4
Ceiling:	Wood truss with RSI 2.1 (R12) insulation with vapour barrier plus ceiling tile Area 350m ² Total insulation value RSI 2.3
Floor:	Dirt covered with plastic sheeting Area 350m ² Total insulation value: RSI 0.7
Walls (below grade):	Concrete with inside RSI 1.3 (R7.5) white styrofoam insulation. Area: 110m ² Total insulation value RSI 1.3
Windows:	Double Thermopane with wood frame Area: 60m ² Total insulation value RSI 0.7
Doors:	Solid wood Area 10m ² Total insulation value RSI 0.7
Infiltration:	Reasonably good Building volume 1500m ³ Assumed air changes per hour 0.75

Calculation of Design Heat Losses

Using the ASHRAE* method of determining the design heat loss of the building and assuming design temperatures of -38°C (outside), 2°C (ground), and 18°C (inside):

Design Heat Loss through the building structure

$$= \frac{\text{Area (m}^2\text{)} \times \text{Design Temperature Difference (}^{\circ}\text{C)}}{\text{RSI (watts/m}^2\text{.}^{\circ}\text{C)}}$$

Design Heat Loss through infiltration

$$= 0.335 \times \text{Volume (m}^3\text{)} \times \text{Design Temperature Difference (}^{\circ}\text{C)} \\ \times \text{number of air changes per hour}$$

Using the school building features listed above, design heat losses are as follows:

<u>Component</u>	<u>RSI (watts/m².°C)</u>	<u>Area (m²)</u>	<u>Design Temperature Difference(°C)</u>	<u>Design Heat Loss Watts (%)</u>
Walls (above grade)	2.4	190	86	6800 (10%)
Basement Walls	1.3	110	16	1400 (2%)
Basement Floor	0.7	350	16	8000 (11%)
Doors	0.7	10	86	1200 (2%)
Windows	0.7	60	86	7400 (10%)
Ceiling	2.3	350	86	13,100 (19%)
Infiltration			86	32,400 (46%)
TOTAL				70,300

* ASHRAE - American Society of Heating, Refrigerating and Air Conditioning Engineers Inc.

Calculation of Annual Fuel Consumption

The annual heat loss may be calculated from the design heat loss and the number of degree days below the inside design temperature (18°C) for the location.

Assuming a degree day value below 18°C of 7500, the annual heat loss is equal to:

$$\begin{aligned} & \frac{\text{Design Heat loss} \times 24 \times \text{Degree Days}}{\text{Design Temperature Difference}} \\ &= \frac{70,300 \times 24 \times 7500}{86} \\ &= 147,000 \text{ kWh/year} \end{aligned}$$

Assuming a 70% oil boiler burner efficiency and a thermal energy content for oil of 10.6 kWh/litre, the annual fuel consumption is estimated to be:

$$\begin{aligned} & \frac{147,000}{10.6 \times 0.7} \\ &= 19,800 \text{ litres/year} \end{aligned}$$

DIESEL HEAT RECOVERY
WEAGAMOW LAKE, ONTARIO HYDRO SITE

Engine/Alternator Sets: 3 diesel alternator sets, 100 KW; manufactured by Mechtron Engineering Products Ltd. of Ottawa. Allis Chalmers Engines and B.B.C. Canada Ltd. alternators.

Specifications: Engines AC model 685T having a continuous rating of 155 H.P. at 1800 RPM at N.T.P. and a fuel consumption of 0.395 LBS/HR at full load. Engines have mounted radiators and engine-driven fans which take approximately 7.75 HP.

Brown Boveri Canada alternators of this size have, at full load, an efficiency of 91%.
 Net Caloric Value Fuel = 18,400 BTU/LB.

Derived: $\frac{100 \text{ KW} \times 1000}{746 \times 0.91} = 147.3 \text{ Shaft Horsepower (SHP)}$

Fan = 7.75 SHP

Total SHP = 155.05

		<u>BTU/HR</u>	
Total Fuel Heat:	155 X 0.395 X 18400 =	1,126,540	(100.00%)
SHP as BTU/HR:	155 X 42.44 X 60 min =	694,392	(35.04%)
Electricity KN as BTU/HR:	100 X 56.92 X 60 min =	341,520	(30.32%)
Fan & Alternator Losses:		53,172	(4.72%)
Fan Losses:	7.75 X 42.44 X 60 min =	19,732	(1.75%)
Alternator Losses:		33,437	(2.97%)
Heat to Jacket Coolant and Radiation and to Exhaust Gas and Radiation:		731,800	(64.90%)
Radiation Losses of Jacket and Exhaust:		123,919.4	(11.0 %)
HEAT TO COOLANT AND EXHAUST GAS (USEABLE)		607,581	(53.96%)

Ratio of exhaust gas heat to coolant heat on full load = 1.17:1

	<u>BTU/HR</u>	
Therefore, heat coolant (useable)	= 280,129	= (24.87%)
Therefore, heat to exhaust (partially useable)	= 327,799	= (29.09%)

From the exhaust gas with 327,799 BTU/HR, 220,394 BTU/HR or 67.24% can be recovered as heated liquid. 220,394 is 19.56% of fuel heat.

The fan and alternator losses total 4.72% of fuel heat.

**Summary of
Recoverable Heat:**

From Jacket	250,129 BTU/HR	
From Exhaust	220,394 BTU/HR	
Total for Remote Heating	<u>500,523</u> BTU/HR	
Radiation from Engine	123,919 BTU/HR	
Radiation from Alternator	22,531 BTU/HR	
Total for Engine Room Heating	<u>146,450</u> BTU/HR	
Total Heat Recovery (Full Load)	646,973 BTU/HR	(57.43%)
Electrical Load	341,520 BTU/HR	(30.32%)
Total Thermal Efficiency	988,493 BTU/HR	(87.75%)

The final exhaust gas temperature from the exhaust would be 410°F. This temperature could be taken lower to a minimum of 350°F. However, at partial load the temperature would be lower than 410°F; 350°F is the lowest desirable temperature at any load.

If the exhaust heat is not recovered then the total heat for remote heating becomes 280,129 BTU/HR 24.87% and the thermal efficiency drops to 68.19%.

The following schematics show heat recovery designs for the Weagamow diesel sets with:

- A) Complete heat recovery; and
- B) Recovery of coolant heat only.

